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AN
Hiſtorical *and* Philoſophical
ACCOUNT
OF THE
BAROMETER,
OR,
WEATHER-GLASS.

WHEREIN

The Reason and Use of that Instrument,
the Theory of the *ATMOSPHERE*, and
the Causes of its different Gravitation,
are Aſſigned and Explained.

AND

A Modest Attempt from thence made towards a rational
Account and probable Judgment of the Weather.

By *EDWARD SAUL*, A. M.
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of *Harlaxton*, *Lincolnſhire*.

The Third Edition, Corrected.

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To His GRACE

JOHN,

Duke of RUTLAND, *Marquis of* GRANBY, &c. *Chancellor of the Dutchy of* LANCASTER, *and Knight of the Moſt Noble Order of the* GARTER.

My LORD,

THE following Tract Your Grace is intituled to upon many Accounts. It was drawn up in Part above Twenty Years ago, and deſigned for your Amuſement in Philoſophy, when I had the Honour of living in the Family with you at *Belvoir*; it has, at ſeveral times, been talked over to Your Grace in Converſation, as Occaſions offered: It was ſome time ſince preſented to You in Manuſcript, and now, with ſuch farther Additions and Alterations, as, upon a careful Review, I found Reaſon to make, waits upon Your Grace from the Preſs.

I AM very far, my Lord, from pretending herein to offer to Your Grace any thing new, or extraordinary upon the *Barometer*; Mr. *Boyle*, Dr. *Halley*, and other Philoſophers of Note, having, in a good meaſure, anticipated what can be ſaid upon it, and left little more to any ſubſequent Writers, than the Neceſſity of treading in their Steps, of building upon their Foundation, or perhaps, in ſome Inſtances, of giving ſome farther Light and Confirmation to thoſe Principles they have laid down for the Explanation of it. Agreeably to which, what lies ſcattered and diſperſed in ſeveral Authors and Volumes; what I had formerly the Opportunity of learning under Dr. *Keil*, at *Oxford*; what I have ſince, either ſeen, read, collected, or obſerved, of any Conſequence, or Relation to the Subject, is here worked up together into one conſiſtent Scheme, and at one View ſubmitted to Your Grace's Peruſal.

THE Pleaſure Your Grace takes in Speculations of this Kind, eſpecially in ſuch as are agreeable to Nature and Reaſon, is the beſt Apology I can make for the Freedom of addreſſing theſe to You; but the real Motive that induces me to it, is rather to do Juſtice to Your Grace, in what the World muſt allow to be a very bright and diſtinguiſhing Part of Your Character.

IT is recorded, by *Plutarch*, of the Elder *Cato*, that he was well advanced into Years, before he entered upon the Study of the *Greek* Tongue; or, as the *Roman* Hiſtorian ſays of him, *Literarum cupidiſſimus, earum ſtudium ſenior arripuit; tantum vero in eis progreſſum fecit, ut non facile reperire poſſis, neque de Græcis, neque de Italicis rebus, quod ei fuerit incognitum.*

ANOTHER Inſtance of the like Nature is related of a famous Author of the laſt Century; who (being often puzzled, and perplexed by the inquiſitive Temper of his Son, and aſhamed of not being able to give him a rational and ſatisfactory Anſwer) betook himſelf to his Accidence at the Age of 44, and made ſo quick a Progreſs in his Studies, from ſo late a Beginning, that before he was 60, he had publiſhed three or four *Folios* of Collections and Tranſlations out of the learned Languages.

THESE, my Lord, and the like extraordinary Efforts of a ſuperior Genius, are always mentioned with Marks of Eſteem and Approbation; and as they are always previouſly grounded upon good Senſe, attended with great Difficulties, and require an unwearied Diligence and Conſtancy in putting them in Execution; it muſt be, at the leaſt, equally laudable, and highly for Your Grace's Honour, to exert and diſtinguiſh Yourſelf in the ſame uncommon Purſuits of Learning.

IN Your early Years, You had gone through the cuſtomary Forms of a faſhionable Education, in acquiring a little Smattering of *French* and *Latin*, a general Inattention to Books, and Attachment to Sports: But this, my Lord, was a Scene of Life too mean and ignoble for Your Grace's active Soul to be confined in. Conſcious of many heavy Hours hanging upon your Hands, You had Recourſe to Muſick, and made the moſt ſurprizing Progreſs in it. Conſcious of the Want of a Fund of Learning, ſuitable to Your natural Genius and Capacity, You engaged in reading the beſt *French* and *Engliſh* Authors: But even theſe, my Lord, not being fully ſatisfactory to Your impatient Thirſt of Knowledge, You deliberately formed, and, without Heſitation, executed the noble Reſolution, not only of Acquireing a competent Skill in the Language, Style and Beauties of the Claſſics, but even of going back to the Rudiments of Grammar, and of grounding the Courſe of Your Studies upon a new and regular Foundation.

AND thus, my Lord, the Opportunity, unhappily loſt in the former Part of your Life, You wiſely retrieve in the Sequel of it; and what ſhould have been the Employment of Your Youth (rather than be defective in any Part of polite Literature) You have made it Your Choice to purſue in Your manly Years; and that with ſo great Steadineſs and Application, as if You were daily accountable for the Progreſs of your Studies; or that the noble Diſtinction of Birth, Honours and Fortune, You ſo liberally enjoy, could not ſit eaſy upon You, without a Superiority of Senſe and Learning, anſwerable to the Superiority of Your Station and Character.

So generous an Ambition, in an Age ſo much addicted to Pleaſure, of excelling in the Improvements of Reaſon; is what the World, my Lord, deſervedly admires, applauds, and congratulates You upon; and what all true Lovers of Learning, muſt, with equal Zeal and Unanimity join, in wiſhing Your Grace the moſt deſireable Health and Succeſs, in carrying on and accompliſhing ſo laudable an Undertaking; though Your Attention to it, will always give Your Friends great Pain and Anxiety, leſt the Conſtitution of Your Body, like that of Your noble Anceſtor, *Edward* Earl of *Rutland*, ſhould be too tender and delicate to ſupport the rapid Progreſs and Improvement of Your Mind.

As Your Grace is now, with ſo much Honour to Your Self, enrolled in the Number of the *Literati*; the Demands and Expectations of the World, will, my Lord, in ſome Proportion, riſe upon You, and from a Man of Senſe and Learning, regularly and naturally expect a diſtinguiſhing Regard to Perſons of the like Character: And that Your Grace will rather follow Your own noble and upright Inclinations in doing Juſtice to Merit, than be too eaſy and compliant, in giving up Your Judgment and Patronage to the leſs cautious Recommendations of others.

It was by ſuch a conſtant and laudable Partiality to Men of Merit, that *Mecænas* ſtands upon Record in more bright and laſting Characters, as a Patron of Learning, than as a public, or prime Miniſter of State. By the very ſame Methods of Favour and Encouragement, the renowned *Scipio*, and *Cicero*, in their Intervals of Retirement from public Buſineſs, made each of them their Villa, or Country Seat, a Sort of Academy, or Society of learned Men; with the great *Roman* Orator, or Stateſman (in a private, but undiſputed Poſt of Honour) preſiding at the Head of them.

BY ſomething of the like Meaſures ſteadily purſued, Your Grace might alſo, by Degrees, tranſplant Men of Virtue, Learning and Merit (which it is always in the Power of great Perſons, by ſuitable Encouragement, to have at Command) into the ſeveral Vacancies, as they ſhall happen, under Your double Right of Patronage; to Your own laſting Honour, to the Service of God and Religion, and to the preſent and future Benefit of thoſe Multitudes of Souls, whom Providence has in ſome meaſure placed under Your Care; and whoſe Inſtruction in the Ways of Life and Happineſs, depends ſo much upon the Choice Your Grace makes, in the Diſpoſal of Your Preſentations.

THAT Your Grace may thus ever employ the noble Privilege of being Great, in the more noble Power of doing Good; that

You may live many Years in a ſettled State of Health and Felicity, and grow old with Pleaſure in the progreſſive Improvements of Learning, Wiſdom, and Virtue; is the general and unanimous good Wiſh, of all who Love and Honour Your Grace; but of no Man, with a more unfeigned Zeal, Reſpect, and Sincerity, than, my Lord,

Your GRACE's *moſt Obedient,*

And moſt Devoted,

Humble Servant,

EDWARD SAUL.

An Hiſtorical and Philoſophical
ACCOUNT
OF THE
BAROMETER,
OR,
WEATHER-GLASS.

THE WEATHER-GLASS being of late grown into common Uſe, and in moſt Houſes of Figure and Diſtinction, hung up as a Philoſophical, or Ornamental Branch of Furniture; and ſupplying often Matter of Diſcourſe upon the various and ſudden Changes of it: It may not perhaps be unacceptable to many Perſons, who daily ſee the Effect, and are not rightly apprized of the Cauſe, to explain the Nature and Reaſon of it.

My Deſign therefore in theſe Papers, is not to write for the Entertainment of Philoſophers, or of thoſe Gentlemen, who by the Advantage of a learned Education, or of a Courſe of Experiments, have had better Opportunities of improving themſelves in Speculations of this Nature: But for the Satisfaction of many of my inquiſitive Countrymen; who having given themſelves and their Parlours an Air of Philoſophy, by the Purchaſe of a *Barometer*, may be willing to know the Meaning of it, and deſirous of exerting now and then a Superiority of Underſtanding, by talking clearly and intelligibly upon it.

The Deſign and Uſe of this Inſtrument, is to ſhew the various Changes in the Weight or Preſſure of the *Air*, and thoſe of the *Weather* depending upon it.

The *Air*, in former Ages, was generally held to be a Body ſpecifically light; or, by its own inherent Spring and Activity, riſing naturally, and mounting upwards: But the Philoſophers of the laſt Century, by various Experiments, have diſcovered and demonſtrated it in reality to be a heavy elaſtic Fluid; heavy, becauſe its upper Parts preſs upon the lower, and thoſe again upon others below them, with a progreſſive

Weight, down to the Surface of the Earth; and elaſtic, or ſpringy, becauſe the Particles of the *Air*, like Wool, are capable of Contraction and Dilatation; capable of being compreſſed within a narrower Compaſs by any incumbent Weight, and of reſtoring and expanding themſelves again, upon the Abatement, or Removal of it.

AND as theſe two Properties, the Weight and Spring of the *Air*, have a mutual Connection and Dependance upon each other, and contribute jointly in producing the Effects obſervable in the *Barometer*; ſo to avoid the Confuſion of arguing from two different Principles, I ſhall conſider them both under one common View, in the Sequel of this Diſcourſe, and by the Preſſure of the *Air*, the Gravitation of the *Atmoſphere*, and other ſynonymous Expreſſions, I would be here underſtood to mean, not the Weight of the *Air*, diſtinct from the Spring of the *Air*; but the compound Effect (as they both act in Conjunction) reſulting from both, and as for the particular Effects of the Spring of the *Air*, ſo far as they are neceſſary, and bear a Relation to this Subject, they will be conſidered and explained in their proper Place.

As the general Gravitation of the *Air* upon the Surface of the Earth, has been much the ſame in all Ages of the World, and the Effects proceeding from it, conſtant and regular; it was ſcarce poſſible for any profeſſed Obſervers of Nature to avoid takeing Notice of ſome of them, and accordingly, the Riſe and Support of Water within the Bole of a Pump, the Aſcent and Running of Liquor through a Syphon, the Suction and Detention of Water in a Syringe, *&c.* fell under the Obſervation of the Philoſophers of former Ages: But then to palliate their Ignorance of the true Cauſe, they falſly aſcribed theſe and the like Effects, to an imaginary *Fuga Vacui*; to a myſterious and unaccountable Dread in Nature of a Space void of all Matter, which it was taken for granted, would be attended with ſuch deſtructive Conſequences, that Nature reverſed her ordinary Laws, and cauſed even heavy Bodies to mount upwards, to prevent or avoid it.

THIS unphiloſophical Account was juſtly exploded by *Galilæo*, a celebrated Mathematician of *Piſa* in *Italy*, who advanced and maintained it, as an undeniable Truth in Philoſophy, as well as Mechanicks, that no heavy Body aſcended, without another Body equally heavy deſcending in counterpoiſe to it; and in the Conſequence of this, he was the very firſt that ſuſpected and ſuggeſted this præter-natural Aſcent of Fluids (as it was then accounted) to have a regular natural Cauſe anſwerable to it, in the ſecret and inviſible preſſure of the *Air*.

THIS Hint of *Galilæo*, was farther purſued and improved by the famous *Torricellius*, a *Florentine*; who, about the Year 1643, amongſt other Experiments for diſcovering the Weight of the *Air*, formed the firſt rough Model of a *Barometer*, in a Pipe, or Tube, of 60, and afterwards of 40 Feet in Length; which being immerged and ſuſpended in a Veſſel of Water, and the *Air* extracted by a Sucker, the Water was always obſerved to follow the Sucker, and to riſe and continue ſuſpended within the Tube, to the Height of 32, or 33 Feet, with ſome little Variation, but could by no Art be drawn or kept up to the Height of 38 or 40 Feet: which plainly proved the *Fuga Vacui* not to be infinite, but to be limited within narrow Bounds, and thoſe prefixed by natural Cauſes, admitting of no Encreaſe, or Exceſs.

BUT this Inſtrument of *Torricellius*, being of an unmanageable Length and Size, and requiring the help of a Windmill Sail to invert the Tube; by comparing their ſpecific Gravities, and filling a Tube of Glaſs with Quickſilver inſtead of Water (which ſome Authors ſay, was altogether accidental) he found the Effect equally, and ſurprizingly to anſwer; and by the Advantage of ſo heavy a Fluid, he reduced the *Barometer* in its Length, from 40 Feet, to 32 or 33 Inches. This was the State in which *Torricellius* framed and left the *Barometer* (from him in the Writings of the modern Philoſophers uſually called the *Torricellian* Experiment) and which indeed, was only applied at the firſt to prove the general Gravitation of the *Air*, without drawing any other Philoſophical Concluſions from it.

The Honour of ſtill farther improving the *Barometer*, and of bringing it to a greater Degree of Exactneſs and Perfection, was reſerved for the noble and ſagacious Mr. *Boyle*; who, by frequent Obſervations and Experiments, was the firſt that convinced the World of the great Inequality in the Gravitation of the *Air* at different Times and Places; and that contrary to the received Opinion, the Preſſure of the *Air* was greateſt, when it was moſt clear and ſerene, and leaſt, when it was moſt charged with Clouds and Vapours; becauſe in fair Weather, the *Mercury* uſually roſe and kept up to the Height of 29 ½ or 30 Inches; but in changeable, rainy, or ſtormy Weather, uſually ſettled to 29, 28 ½ and even ſometimes below 28 Inches.

And from hence not only by obſerving a regular Correſpondence betwixt the Riſe and Fall of the *Mercury*, and the Changes of the Weather; but by marking and adjuſting the preciſe Limits to both, upon a graduated Plate of Braſs, on each Side of the Tube, he brought the *Barometer* into more general Uſe and Service; either as a certain Meaſure of the Weight of the *Air*, or as a variable Indication of the Changes of the Weather.

How, and why it is ſo, will appear from the Conſtruction of the *Weather-glaſs*, which in the common Form, is made after the following Manner.

TAKE a Glaſs Tube of about 35, or 36 Inches long, and near half, or the third Part of an Inch in the Diameter; cloſed or hermetically ſealed at one End, and open at the other. Fill it up with *Mercury*, or Quickſilver, well cleared and purified; then, ſtopping the Orifice cloſe with your Finger, invert the Tube, and plunge it together with your Finger into a Baſon of Quickſilver, and when it is fixed or ſuſpended in a perpendicular Poſture, with the Orifice of the Tube below the Surface of the *Mercury*, at a little diſtance from the Bottom of the Baſon, withdraw your Finger from the Orifice of the Tube.

IT is found by Experience, that only ſuch a Part of the Quickſilver within the Tube, will ſubſide and run out into the Baſon, as exceeds the Weight of a proportional Column of *Air*, and that the remaining, and far greater Part of the Quickſilver will continue ſupported within the Tube, exactly at ſuch an Height, as comes to an *Æquilibrium* with it.

FROM hence it follows, 1*ſt*, That by the ſubſiding of the *Mercury* from the Top of the Tube, the intermediate Space (being uſually about ſix or ſeven Inches) is left entirely void of *Air*, and this is abſolutely neceſſary in a good *Barometer*, as well to give Liberty to the outward *Air* to exert its Force, as to give room to the Riſe of the *Mercury* within the Tube, upon any Increaſe in the Gravitation of the *Air*. 2d, If there be any Bubble of *Air* confined within the Cylinder of *Mercury*, it will by a conſtant Endeavour to free itſelf from Preſſure, after ſome little Time, diſengage itſelf, and make its Way to the Top of the Tube; and there rarefying and expanding into a larger Compaſs, it will in ſome meaſure defeat the Uſe and Exactneſs of this Inſtrument; upon which Account the true *Torricellian* Tube, is not made entirely of a *Cylindrical* Form (as in the common *Weather-Glaſs)* but ſpreads out into a large Bolt Head, or ſpherical Cavity at the Top, ſo that if there be any *Air* remaining in the Tube, it may have there ſufficient Room to expand itſelf, without affecting or depreſſing the *Mercury*. 3d, From hence alſo it farther appears, that the *Mercury* within the Tube is kept ſuſpended, by the Gravitation of the external *Air* upon the Surface of the ſtagnant *Mercury* in the Baſon.

To make this ſtill more evident, take a ſtrong *Glaſs Cylindrical* Tube, cloſed at the upper End, with a Sucker well fitted to the inward Cavity, well moiſtened, and preſſed up to the very Top of it; immerge this with the *Air* within it, into a Veſſel of Water, and no Water can, or will riſe up in it, becauſe the Reſiſtance of the *Air* within the Tube, is equal to the Preſſure of the *Air* without; then keeping the lower and open End ſtill under the Water, draw back the Sucker by main Force, and the Moment the *Air* and Sucker are extracted out of the Tube, the Water will immediately ruſh in, and ſhoot up with ſurpriſing Force and Velocity to the Top of it.

To account for this, we muſt have recourſe to a known Law in *Hydroſtaticks, viz.* That all Fluids, under a State of Compreſſion, direct their Motion that Way, towards which there is the leaſt Reſiſtance. Now the Tube, by the Experiment above-mentioned, having no *Air* within, and the *Air* without, lying as a Weight incumbent upon the Surface of the Water, it is evident that the Preſſure of the outward *Air*, can only act and exert itſelf, by forcing the Water up the Tube, where there is no Reſiſtance, nothing to oppoſe its Paſſage. And this it will do, 'till either the Extremity of the Tube ſtops its Aſcent, or 'till the Weight of the Water, within the Tube, is equal to the Preſſure of the *Air* without.

THE very ſame Effect is clearly ſhewed, and undeniably proved, by placing the Tube of a *Barometer*, with its Ciſtern of *Mercury*, in the *Air* Pump; for ſo long as the *Air* within the Receiver continues in its natural State, the *Mercury* will keep up to the ſame Height; but when the Pump is working, and the *Air* exhauſting, the *Mercury* will gradually ſubſide in the Tube, 'till it comes to near the ſame Level with that in the Baſon. Open the Communication with the external *Air*, and let it by Degrees into the Receiver; and then the *Mercury* will gradually riſe up again in the Tube, and recover its former Height. And thus, as often as you repeat the Experiment, the *Mercury* will alternately fall, or riſe in Proportion as the Preſſure of the *Air* is diminiſhed by pumping it out, or renewed by the Re-admiſſion of it.

TO this I ſhall only add a more eaſy and obvious Experiment, *viz.* that of pouring Water upon the *Mercury* in the Ciſtern, raiſed for this Purpoſe to the Height of two or three Inches; for as the Water is heavier than the *Air*, it will to a greater Degree increaſe the Preſſure upon the ſtagnant *Mercury*, and in the Conſequence of it, raiſe that in the Tube proportionably higher. Draw off the Water by a Pipe, and, in Proportion as the Weight decreaſes by the *Air* ſucceeding in its Place, the Quickſilver in the Tube will gradually deſcend, and ſettle as before, to its lower Station.

FROM theſe Experiments, and the Concluſions grounded upon them, it is to Demonſtration evident, that the general and perpendicular Preſſure of the incumbent *Air*, or *Atmoſphere*, upon the Surface of the Earth, is the Force that raiſes up the *Mercury* in the empty Tube; that the very ſame Preſſure of the *Air*, is the Counterpoiſe that ſupports the *Mercury* at its proper Height; and that they are only the various Changes in the Gravitation of the *Air*, that produce the correſpondent Changes in the Riſe and Fall of the *Mercury*.

FROM hence alſo it appears, that the little Vacuity in the upper Part of the Tube, is in reality the main Spring and Engine that keeps the *Barometer* in play; that directs and determines the general Preſſure of the *Air*, to its particular Uſe and Service; and even confines it to diſcover the daily Changes it undergoes in its own Gravity, by bringing it there to the Teſt, and weighing in a Philoſophical Balance, a Column of *Air*, againſt a Cylinder of Quickſilver.

FOR if you break the Tube, and deſtroy the *Vacuum* in the upper Extremity, by letting in the outward *Air*, you deſtroy the Balance that keeps the *Mercury* ſuſpended; which will immediately fall down into the

Ciſtern, and the Effect we are here accounting for, entirely ceaſe.

So ridiculous and groundleſs is the Dread of a *Vacuum* in Nature, and ſo uſeful when rightly applied (in Pumps, in Fire and Water-Engines, *&c.)* in doing the Drudgery, and contributing to the Eaſe and Benefit, the Relief and Entertainment of Mankind.

By the Premiſes it is abundantly proved, that in a common *Weather-Glaſs*, the *Mercury* within the Tube, gravitates as much upon that Part of the ſtagnant *Mercury*, lying directly under it, as the *Air* does upon the reſt of the Surface of the *Mercury* in the Baſon; and, conſequently, that a Column of *Air*, reaching to the Top of the *Atmoſphere*, is of the ſame Weight with a Column of *Mercury* of the ſame Baſe and Height with the *Mercury* in the Tube, *i. e.* in other Words, 29 or 30 Inches of Quickſilver, is equivalent in Weight to a proportional Column of *Air*, riſing and reaching above 5 Miles in Height. For ſo high, at the leaſt, muſt we extend the *Atmoſphere*, or that mixed Fluid, conſiſting of *Air*, *Clouds* and *Vapours*, that ſurrounds the Earth, and gravitates upon it, as will appear by the following Calculations.

For as the comparative Gravity of Quickſilver to Water is as 14 to 1, and the comparative Gravity of Water to *Air*, as ſtated by Dr. *Halley*, is as 840 to 1, conſequently by theſe Proportions one Inch of a Cylinder of Quickſilver, is equivalent in Weight to 14 Inches of an equal Cylinder of Water; and to 1160 Inches, or 980 Feet of an equal Cylinder of *Air*; and from hence it follows, that a Column of Quickſilver of 30 Inches (being the uſual Height to which the *Mercury* in the *Barometer* is obſerved to riſe in fair Weather) is equal in Weight to a Column of *Air* of the ſame Baſe, and 294000 Feet high; which is ſomething more than five Miles and an half.

BESIDES this, there is another Way, equally eaſy and entertaining, of computing the Height of the *Atmoſphere*; and that is, by taking the perpendicular Height of any very high Mountain, and at the ſame Time nicely remarking the different Elevation, or Depreſſion of the *Barometer* on the Ridge, and at the Foot of it; for then, as the Difference in the Height of the *Mercury* above and below, is to the whole Height of the *Mercury* at the Foot of the Mountain, ſo will be the Height of the Mountain, to the Height of the *Atmoſphere*. For Inſtance;

LET us ſuppoſe the *Barometer* to ſtand at 30 Inches in the Valley, and to ſink down to 27 on the Ridge, or Top of the Mountain, and the perpendicular Height of the Mountain itſelf to be 1000 Yards, then it will follow, that as 3 to 27 the Height of the *Mercury*, ſo 1000 Yards, the Height of the Mountain, to 9000 Yards the Height of the *Atmoſphere*, which is much the ſame with the other Computation, being about five Miles and five Eighths in Height.

How little the Proportion here allotted, of 1000 Yards to 3 Inches Fall in the *Mercury*, varies from the Truth, appears from hence, that Mr. *Caſwell* (a noted Mathematician of *Oxford)* meaſured *Snowden* Hill in *North-Wales* (reputed the higheſt Mountain in *Britain)* and found it to be 1240 Yards high; and the celebrated Dr. *Halley* afterwards, by ſeveral exact Tryals, at the Foot and Top of the Mountain, found the *Mercury* to deſcend three Inches and eight Tenths of an Inch. Vide *Harris*'s *Lexicon. Barometer. Derham*'s *Aſtrotheology*, page 114, and 115.

From whence it follows, that the Fall of the *Mercury* one tenth Part of an Inch, is very near equivalent to 32 Yards and two Feet; the Fall of the *Mercury* one Inch, is equivalent to 326 Yards two Feet, and the Fall of the *Mercury* three Inches, is equivalent to 980 Yards.

These Computations, it muſt be owned, are not entirely exact and accurate, nor indeed capable of being made ſo, becauſe the *Atmoſphere* is not in all Places of equal Height, or of equal Weight and Denſity: But ſtill they are ſufficient to juſtify the

Conjectures of Philoſophers in extending the Height, and Gravitation of the *Atmoſphere,* to the Diſtance of five or ſix Miles, though others, upon Account of the *Air* growing lighter in Proportion, as it riſes higher, carry it much farther.

AND as the *Atmoſphere*, or Body of *Air* ſurrounding the Globe, is unequal in its Height and Denſity, it muſt be conſequently unequal in its Preſſure; ſometimes lying with a greater Weight upon the Surface of the Earth, than at others. When the *Air* is light, or the *Atmoſphere* low, (as on the Top of an high Hill, where the Cylinders of the incumbent *Air* are proportionably ſhortened) the Counterpoiſe that ſupports the *Mercury* in the Tube being diminiſhed in the Weight, the *Mercury* muſt conſequently fall; but if the *Atmoſphere* be deep, or the *Air* grows heavier, and preſſes with a greater Weight upon the Surface of the ſtagnant *Mercury*, the *Mercury* within the Tube muſt conſequently riſe higher, that it may be equal in Weight to the Column of *Air* preſſing upon it, or to the preſent Weight of the *Atmoſphere*.

FROM hence it follows, that the *Mercury* riſing and falling (as it regularly does) according to the different Changes in the *Air*, may be fitly uſed and applied, as a proper Meaſure and Indication of the Gravity of it, and upon this very Account, it receives the

Name of a *Barometer*, becauſe it meaſures and marks out to us, the different Degrees of its Gravitation; ſometimes the *Mercury* may be obſerved to riſe to the Height of 30 $\frac{1}{2}$ Inches, ſometimes it ſtands at 29, or 28, and at other times ſinks even ſo low as 27 $\frac{1}{2}$ Inches, but ſeldom under; and as this Difference is produced by the Preſſure of the *Air*, it is certain the *Air* itſelf muſt be ſome Way or other liable to a proportional Change in its Gravitation.

For as Gravity is inſeparable from Matter, and is always proportionable to the Quantity of Matter that weighs; it is impoſſible that the *Air* ſhould change its Gravity, without changing in like manner its Quantity of Matter; and upon this Account, ſome have (without due Conſideration) imagined, that this Difference of the *Air*'s Gravity proceeded from its being more or leſs charged with Vapours: If this were the Cauſe of it, there muſt be as much Vapour in the *Air* at a Time, as is equal to the Weight of three Inches of *Mercury*; for ſo much do we commonly find the *Mercury* to riſe and fall. Now *Mercury*, as we have before obſerved, being 14 Times heavier than Water, there muſt be conſequently in the *Air* at once, as many Vapours as will equal in Weight a Column of Water 42 Inches in Height, and whoſe Baſe is equal to the Surface of the Earth; which is not only incredible, but found in Fact to be more than falls in Rain in a whole Year.

For at *Paris* and *Liſle* (where the *Mercury* varies, as with us, near three Inches) the Quantity of Rain falling in one Year, by a Medium of ſix Years, amounts to no more than 21 Inches in Height. At *Zurich* in *Switzerland* to 32 Inches. By the accurate Obſervations of Mr. *Derham* at *Upminſter* in *Eſſex* to $19\frac{1}{4}$. By the Tables of Rain kept by Mr. *Townley* of *Lancaſhire*, it is ſtated by a Medium of 15 Years, at 41 Inches. But as theſe two *Engliſh* Accounts, ſeem each of them to border upon oppoſite Extremes, the mean Proportion of Rain falling one Year with another, and taking one Part of *England* with another, may be fairly eſtimated at the perpendicular Height of 30 Inches.

The Reaſon then, why the *Air* is heavier at one Time than another, cannot be from the Quantity of Vapours floating in it; but ſeems rather to ariſe from there being more *Air* on that Part of the Earth's Surface, where ſuch Preſſure is encreaſed. And this ſeems chiefly to proceed from the Winds. For Example:

If the Wind, which is nothing but a Stream of *Air*, ſhould blow upon any Place, and the *Air*, thus ſet in Motion, ſhould be check'd in its Progreſs, or reflected upwards, by the Oppoſition of Mountains and Hills;

or if two contrary Winds ſhould, at the ſame Time, blow towards the ſame Place, the *Air* will be, as it were, piled and heaped up for ſome Diſtance on each Side, by their Meeting and Oppoſition; and, conſequently, there being in both theſe Caſes, more *Air*, its Gravity will be encreaſed.

But if the Wind blows with any Degree of Strength, or Steadineſs, over a plain Country, the *Air*, which before reſted upon it, will be ſwept along with it; or if two contrary Winds ſhould at the ſame Time blow from off the ſame Continent, the *Air* independent over it, will be thereby greatly thinned and attenuated; nor can the Spring of the *Air* bring in Supplies faſt enough to anſwer ſuch a double Evacuation. So that in each of theſe Caſes, the *Air*, growing leſs in Quantity, will be conſequently lighter: As, at the ſame Time, the great Force and Swiftneſs of its horizontal Motion, will, it is reaſonable to imagine, intercept and abate ſome Part of its perpendicular Preſſure.

Thus alſo, as the *Air* is condenſable by Cold, when the Wind blows from the *Eaſterly* or *North-Eaſterly* Points, it will of courſe bring from thoſe frozen Climates, a great Quantity of their heavy and condenſed *Air* along with it: As on the other Side, the *Air* being dilatable by Heat (when the Wind blows from the *Southerly* Quarters, it will, in like Manner, drive a Stream of warm and rarefied *Air* through the *Atmoſphere*; and, by this means, the Quantity of *Air*, being increaſed in the one Caſe, and diminiſhed in the other, the *Atmoſphere* lying within the Courſe of theſe warm, or cold Winds, will be conſequently lighter, or heavier. And as beſides theſe ordinary Streams of *Air*, there are other irregular Blaſts of Wind, that do not move horizontally, but in oblique, or ſpiral Directions, ſometimes riſing upwards, or inclining downwards; ſo to theſe we may probably aſcribe ſome of thoſe ſudden and extraordinary Variations in the Weight of the *Air*, which are not ſo eaſily accountable for in a more common and natural Way.

IN theſe therefore, as well as in other Inſtances, the Winds ſeem to be the chief Agents in varying the Quantity and Temper of the *Air*, and cauſing ſo great a Difference in its Qravitation.

WHEN the *Air* is heavy, the Vapours riſe with the greater Eaſe and Freedom, and continue ſupported in larger Quantities at a greater Height from the Surface of the Earth. And this Exhalation of Vapours, proceeds partly from a ſubterraneous Heat, (ſtreaming out from the Center, or Bowels of the Earth; and in its Paſſage through the Waters, raiſing ſometimes a ſenſible Reek, or Steam, like that of warm Water over a

Fire, and carrying it up into the *Air* along with it) but chiefly, from the Rays of the Sun; which, falling obliquely upon the Surface of the Water, and being many of them reflected back, with minute aqueous Particles adhering to them, or thin watry Caſes ſurrounding them, are, by that means, ſuppoſed to raiſe copious and continual Exhalations from it.

These Vapours being rarefied to a great Degree, and (as Dr. *Halley* and Mr. *Derham* imagine) formed into real, but imperceptible Bubbles by the Heat, and actuated by the Rays of the Sun, grow ſpecifically lighter than the *Air*; and, conſequently muſt riſe 'till they come to an *Air* of the ſame ſpecific Gravity with themſelves, where they will reſt.

As in a Glaſs Veſſel, filled with three different Liquors, and each of them of different ſpecific Gravities; (ſuppoſe ſalt Water at the Bottom, Wine in the Middle, and Oil at the Top) the Conſequence will be, that the very ſame Cube of Oak-Wood, that riſes up through the Water, and ſwims in the Wine, will yet ſink down through the Oil: The middle Liquor being therefore of the ſame ſpecific Gravity with the Wood, there it will reſt. To carry on the Parallel ſtill farther, let us ſuppoſe it poſſible, by ſome chymical Infuſion, to make a common Mixture of theſe three different Liquors, either of equal Weight and Denſity with the Water, or of equal Levity with the Oil: Then it is evident, that the Cube of Wood will, in the former Caſe, riſe and float at the Top; and in the latter Caſe, ſink down to the very Bottom.

AND thus, in Proportion to the Weight of the *Air*, and the Denſity, or Rarefaction of the Vapours themſelves, they will either float near the Surface of the Earth, under the Appearance of Miſts, or Fogs; or elſe, mounting up out of Sight, they will range themſelves in higher or lower Regions of the *Atmoſphere*, ſuitably to their ſpecific Gravity, where they will reſt. And if at any Time, during their Suſpenſion, the State of the *Atmoſphere* varies by any ſudden Attenuation, or Compreſſion, in the Regions above; the Situation of the Vapours will, in like manner, change with it, either by a farther Aſcent upwards, or Depreſſion downwards, according as the Weight of the *Atmoſphere* is encreaſed, or diminiſhed.

IT is only a vaſt Collection of theſe Steams, Miſts and Vapours, thus raiſed from the Surface of the Earth and Sea, thus carried up and ſupported at different Heights, thus floating in ſeemingly large compacted Bodies, and thoſe confuſedly driven together and accumulated by the Winds, that form the Clouds; which are, in reality, no other than exalted Miſts, or Magazines of Vapours, ranged above, in higher or lower horizontal Planes, in Proportion to the comparative Denſity, or Rarefaction of the Vapours themſelves, with that of the *Atmoſphere*, or Medium, wherein they are buoyed up. (And in this Senſe, we may clearly underſtand, and rationally account for the Balancings of the Clouds; an Expreſſion frequently admired in the Book of *Job* (37. 16.) as being ſtrictly true in a Philoſophical, noble and elegant in a Poetical Senſe, and very juſt and natural in both.

THAT the Clouds and Miſts are much alike, and differ chiefly in their Diſtance, Situation, and Appearance, is ſometimes evident to Sight; becauſe the very ſame Body of Vapours floating near the Earth as a Miſt, when they are raiſed higher, or driven farther off by the Wind, or Sun, change their Appearance into that of Clouds, which they ſo nearly reſemble, as not to be with any certainty diſtinguiſhable from them. And for a farther Proof of this, *Varenius (Geog. Gen.* pag. 66.) ſpeaking of the Mountains of *America*, relates, that *Multa Peruvianorum montium faſtigia perpetuis teguntur nivibus tam æſtate, quam hyeme; multa nubibus involvuntur; quædam ultra mediam aeris regionem elevantur.* And afterwards of the Pike of *Teneriff*, pag. 69. *Vertex illius ſupra nubes attolli videtur manifeſtè; cum hæ medium montem cingant;*

vertex extare ſupra has nebulas conſpiciatur. i. e. As Clouds are commonly obſerved to adhere to the Sides, and to hang round the middle Parts of the Pike of *Teneriff*, and other exceeding high Mountains: So ſome curious Perſons and Travellers (who have happened to climb theſe Mountains when they appeared thus begirt with Clouds) have, for ſome Time, in their Aſcent upwards, found themſelves involved in thick and heavy, in damp and drizzling Miſts; which, to themſelves afterwards from above, and to the Spectators from below, have ſtill retained the Appearance of Clouds.

OUT of theſe Magazines and Collections of Vapours, thus floating and ſupported in the *Air* (according to the different Changes they undergo from the Seaſon of the Year, the Temper of the Winds, and the Warmth, or Coldneſs, of the ſuperior Regions) the ſeveral Kinds of aqueous Meteors are formed and ſupplied, which under ſo many different Appearances, fall back upon the Surface of the Earth, as that excellent Author, Mr. *Derham (Phyſ. Theol.* pag. 20. *&c.)* in a Manner very rational, deduces and explains.

SUCH Vapours as are raiſed by the declining Sun, or hang near the Surface of the Earth, being condenſed by the Coldneſs of the Nights, in the Summer fall back in Dews, and in the Winter in hoary Froſts.

In what we call a black Froſt, either the Riſe of the Vapours is quite intercepted; or rather they are raiſed too high to be reached and precipitated by the Cold below. When the Vapours approaching nearer to each other, are frozen in the Clouds, and broken by the Reſiſtance and Fluctuations of the *Air*, or the cold Winds paſſing through them, they then fall down in Flakes of Snow. When the Vapours are beginning to run into ſmall Drops, and are precipitated by the Cold above, before they are compleatly formed, they then fall down in mizzling Rains; or, if frozen, in Sleet. And as the ordinary Drops of Rain, freezing in their Deſcent, form Hail; ſo whenever they happen afterwards in their farther Deſcent downwards, to paſs through a Cloud of Snow, they encreaſe in Bulk, and gathering, in a literal Senſe, as a Snow-Ball, form thoſe larger Hail-ſtones (of ſix, or more Inches in Circumference) of which we often read, and ſometimes with Surprize admire and obſerve.

So long as the *Air* continues heavy (being, as we above obſerved, either condenſed, or accumulated in Quantity) the Vapours will be ſuſtained, and the Weather hold fair; but if the *Air* by any Rarefaction, or Diminution of its Quantity turns lighter, the Vapours, which were before in Æquilibrio with it, will preponderate; and being heavier

vier than the *Air*, in which they floated, will conſequently deſcend. In their Deſcent, as they approach nearer to each other, and are continually checked by the Reſiſtance of the *Air*, they muſt be condenſed; and this Condenſation of the falling Vapours will gradually encreaſe, 'till they are compreſſed and collected into ſmall Particles, or Globuli of Water; and theſe again, incorporating with others in their farther Deſcent, they are at laſt formed into bigger Drops, and fall down in Showers of Rain; and theſe Showers will be more or leſs violent, and the Drops larger or ſmaller, in Proportion to the Quantity of the falling Vapours, and the Height from whence they deſcend.

FROM theſe Premiſes it clearly follows, that when the Quick-Silver in the Tube, riſes and continues high (being ſupported by the extraordinary Weight of the *Air)* then the Vapours, will be ſupported too, and the Weather continue fair: But when (by any great Diminution of the Weight of the *Air)* the *Mercury* ſubſides and keeps low; then the Vapours, not being ſupportable, will deſcend with it, and the Weather be rainy, and the Rain more or leſs in Proportion to the Depreſſion of the *Mercury*.

AND as theſe Effects uſually follow, and, for the moſt part, regularly correſpond with the Cauſes here aſſigned: So it is upon theſe Principles that the common *Weather-Glaſſes*

are

are made; and upon theſe only, that they are capable of being rightly underſtood and explained.

FROM hence alſo (eſpecially from what has been ſaid above upon the *Air* and Winds) may be drawn ſeveral other Obſervations and Concluſions relating to the ſame Subject, and giving ſome farther Light to it.

1. AS the Winds encreaſe the Quantity and Weight of the *Air*, and by that means ſupport the Vapours; ſo are they ſometimes the immediate Occaſion of their falling: For when, for Inſtance, the Winds blow from oppoſite Quarters, the Miſts and Vapours floating in the different Streams of *Air*, muſt be forcibly driven againſt each other, and confuſedly mixed and blended together: And as they were before ſeparately Æquiponderant to the *Air*, and for that reaſon floated in it; ſo after ſuch Confluence and Conjunction, they will doubly exceed the Weight of the *Air*, and force their Deſcent through it. And this is uſually the Cauſe, both of the largeſt Drops, and of the greateſt and moſt plentiful Rains, as we ſhall have Occaſion more fully to deſcribe in another Place. But when either of theſe oppoſite Winds riſes and prevails, and turns the whole Stream of Clouds and Vapours only one Way, it ſoon clears the *Hemiſphere*, and reſtores better Weather. From hence

alſo we may farther obſerve, That the particular Effect the Winds have upon the Changes of the Weather, depend, in a great meaſure, upon the preſent State and Quality of the *Atmoſphere*; for when that is moiſt and damp, or charged with Clouds and Vapours, the Change of the Wind into an oppoſite Quarter ſoon produces Rain: But when the *Atmoſphere* is clear and free from Vapours, it adds to the Weight and Quantity of the *Air*; and, by that means, continues and prolongs fair Weather.

2. To ſuch an Accumulation of *Air*, as we have above-mentioned, may very probably be aſcribed the conſtant and ſettled Dryneſs of the Coaſts of *Peru* and *Chili*; where, from 3 to 30 Degrees *South*, and for 12 or 13 Degrees to the *Weſt*, according to *Dampier*, and other Travellers, it never rains. To account for this, it is obſervable, that a conſtant *Eaſt* Wind blows round the Globe for ſeveral Degrees on each Side of the *Æquator*; that the *Andes* in *Peru* and *Chili* (being a Ridge of the higheſt Mountains in the World, and running from *North* to *South*) lie directly croſs to the general Current of the *Air*; and thereby, either break, or intercept the Clouds and Vapours on the *Eaſtern* ſide of the Mountains; or elſe raiſe and accumulate the *Air* on the *Weſtern* ſide, to ſuch an Height and Quantity, as to ſupport the Vapours floating in it to the Diſtance of 250 or 300 Leagues from the Shore;

where the general *Eaſt* Wind (ſinking again to the Level of the Sea) brings, as in other Places, Vapours, Clouds, and Rain along with it. *Dampier*, Vol. 2. W. 78, 79.

3. THE Coaſts of *Guiney*, are, by the ſame Author, (page 80.) reckoned among the wetteſt Places in the World, becauſe lying near the *Æquator*, they are exceeding hot and ſultry; and the Soil (being as Travellers farther obſerve, a looſe and deep Sand) imbibes and retains the Heat of the Sun to ſuch a Degree, as to rarefy and attenuate the lower Region of the *Atmoſphere*; and by ſuch Rarefaction, as well drawing in the Winds upon the Coaſts (*Dampier*, W. 14, 15, 16,) as precipitating the Clouds and Vapours; which the *Air*, weakened by exceſſive Heat, has not either Weight, or Denſity ſufficient to ſupport.

4. TO ſuch an extraordinary Thinneſs, or Attenuation of the *Air*, may be attributed, what we ſometimes with Surprize obſerve; *viz.* the ſudden overcaſting of the Sky, when in a calm ſultry Morning, without any viſible Clouds ariſing from below the Horizon, a clear *Hemiſphere* (by the Deſcent of the Vapours into the lower Regions of the *Air*) unexpectedly becomes hazy, thick and cloudy, and even ſometimes miſty and rainy.

5. IT was an Obſervation made many Years ago by the accurate Dr. *Halley*, that

the *Weather-Glaſs*, in a moderate *Eaſterly* Wind uſually riſes higheſt. The Truth of which, to a careful Obſerver, ſeldom fails of being fully confirmed by yearly Experience. For to go back no farther than the Year 1728, in the Latitude of *Grantham*, a ſettled *Eaſterly* Wind, blowing exceedingly ſharp and cold for ſeveral Days, in the Conſequence of it, ſo far condenſed the *Air*, as to raiſe the *Mercury*, *Feb.* 24 and 25, within a Trifle of 30 ½ Inches. In this Inſtance, the Sky was perfectly ſerene, the Sun ſhined very bright, and the Froſt held very ſharp and ſevere.

ON *January* 11, 1729, The Reverend and learned Dr. *Stukely* being with me, we meaſured the Height of the *Mercury*, and found it ſtanding again at 30 ½ Inches (above which in this Latitude and Situation, it is very rarely obſerved to riſe) but in this latter Caſe, the Weather was milder, and the *Atmoſphere* in all parts equally thick and hazy; the Wind having been for ſome time before in the *Weſt*, then ſetting in for four or five Days full *Eaſt*; and afterwards, juſt at the Time of making the Obſervation, by a very ſudden Turn, reverting back into the *Weſt*. From which alternate Change, and quick Succeſſion of the Winds, it is very certain, that they muſt both of them, for ſome time, and at no great diſtance, continue blowing in direct Oppoſition to each other; and, by that means, accumulated the *Air* impendent over us, to a Degree anſwerable to ſuch an extraordinary Elevation of the *Mercury*.

In each of theſe Inſtances the Weather was ſettled; and continued fair, dry, or froſty, for about Ten Days before and after the Time of Obſervation. To which we may farther add, that as the *Weſterly* Wind is moſt frequent and common, and blows by Intervals, for more than half the Year with us; it is ſeldom that an *Eaſt* Wind can continue for a Week together, without meeting with a ſuperior Oppoſition from that Quarter; and thereby, for ſome Time at leaſt, encreaſing the Quantity and Weight of the *Air*, and raiſing the *Mercury* in the Conſequence of it.

6. As in a moderate *Eaſt*, or *Northerly* Wind, for the Reaſons above given, the Weight of the *Air* is encreaſed: So in a very ſtrong Wind, be the Quarter what it will; (eſpecially if it be *Southerly*, or *Weſterly*,) the Horizontal Flux and Velocity of the *Air*, takes off part of its perpendicular Preſſure. This is evident in Fact, from the *Mercury* ſubſiding always, and keeping low in tempeſtuous Weather. And was even viſible to the Eye in the great Storm 1703. During the Height of which, the *Mercury* was obſerved to ſhake anſwerably to the Con-

cuſſions of the *Air*, in a ſenſible Tremor and Vibration: Sometimes apparently yielding and ſinking under the Violence of an approaching Blaſt; and immediately after, riſing again, upon the Relaxation of it.

In Hurricanes and other violent Storms, beſides the Horizontal Blaſt, there are often ſpiral Eddies and Circumvolutions of the *Air* working upwards; and even ſometimes raiſing and carrying Bodies of Weight and Subſtance aloft with them. From whence it is obvious to infer, that the Preſſure of the *Air*, muſt of conſequence be the leaſt downwards; when by ſuch a contrary Impulſe, it is reverſed and forced upwards: And, in this caſe, the Quickſilver, having no ſteady Counterpoiſe, will be more unſettled, and ſink lower than in any other; as in the Storm 1703, abovementioned. which is the only Inſtance, or Account, I have met with of the *Mercury* falling below 27 $\frac{1}{2}$ Inches. Though in ſome of thoſe unaccountable Eddies, that rebound back from the Earth, and ſeem *(pro tempore)* to ſuſpend the Preſſure of the *Air*, by exerting their Force contrary to it; it is very poſſible that the Vibration, or ſubſiding of the *Mercury*, may be ſtill lower.

8. From hence alſo we may farther obſerve, that ſuch an extraordinary Depreſſion of the *Mercury*, laſts no longer than the Violence of the Storm that cauſes it. For

as ſoon as that of *November* 1703, was over, the *Mercury* roſe again very faſt; being, within leſs than twelve Hours, near changeable; from whence it began falling the Day before. And this the learned Dr. *Halley*, in a like Caſe, with good reaſon aſcribes, partly to the general Recoil of the *Air*, after the protruſive Force of the Wind was ſpent; and partly to the quick and ſudden Acceſſion of new *Air*, to ſupply the great Evacuation made by the Storm. For whenever any Part of the *Atmoſphere* is thus attenuated beyond its mean Denſity, the neighbouring Regions of the *Air*, being more compreſſed, will, by a progreſſive Expanſion, continue pouring in from all Quarters, 'till the *Æquilibrium* be reſtored: And in the conſequence of this, will raiſe the *Mercury* to much the ſame Height it was before, and in leſs time than wherein it was falling.

9. IN miſty, or foggy Weather, (if it be of any Continuance) the *Glaſs* is commonly obſerved to ſtand very high; becauſe the *Air* is uſually then perfectly ſtill and calm, and preſſes with its full perpendicular Weight upon the ſtagnant *Mercury*, without any Interruption, or Abatement.

THE learned Dr. *Wallis* is of Opinion, that the Miſts and Vapours hanging thus in the *Air*, add to, and encreaſe its Preſſure: Which, no doubt, is true in general; becauſe the collective Body of the *Air* and Vapours taken together, muſt be of greater Weight than the *Air* alone.

AND, upon this account, not only in miſty, but in dark, ſettled, calm Weather, (when the Vapours are raiſed and ſupported at a very great Height; and ſo equally and copiouſly diſperſed, that the Sky appears uniformly thick and hazy in all Quarters; without the leaſt Gleam of Sunſhine breaking through, or any Cloud diſtinctly formed in any Part of the *Hemiſphere*:) In ſuch a denſe State of the *Atmoſphere*, the Weight of it is greatly encreaſed; and the Height of the *Mercury* raiſed by it, is uſually near 30 Inches.

BUT as ſoon as this State of the *Atmoſphere* changes, either by the Wind riſing, the Sun breaking out, or both together diſperſing the *Hemiſphere* of Vapours, and forming many of them into large Clouds, ſailing above; the Weight of the *Atmoſphere* immediately diminiſhes upon it, and the *Mercury* will in few Hours ſettle to 29 $\frac{1}{2}$ and ſometimes to 29 Inches.

FROM hence it ſeems obſerveable; 1*ſt*, That the Calmneſs of the *Air*, adds very much to the Weight of it. And 2*d*, That the general and equal Diſtribution of the Vapours, whether in Miſts below, or in a hazy Sky above, acts with a ſtronger and greater Degree of Preſſure, than any partial, or unequal Diſtribution, or Collections of them in Clouds: Which, whether ſuſpended in the *Air*, or moving horizontally, intercept and take off ſome part of the perpendicular Preſſure from the Regions above.

AND agreeably to this latter Obſervation, if we examine the Effect of any particular Column of *Air*, acting upon the *Barometer*, the Opinion of the Vapours adding to the Weight of it, muſt be underſtood with ſuch a Limitation. For the only Reaſon of the Clouds and Vapours floating in the *Air*, is becauſe they are Bulk for Bulk lighter than the *Air*. If therefore we ſuppoſe them to exclude, or take up the Space of a Portion of *Air* equal to themſelves, and heavier than themſelves, it will conſequently follow, that a Cylinder of clear *Air*, muſt and will exert a greater Degree of Preſſure, than a compound Cylinder of *Air* and *Vapours* intermixt of the ſame Dimenſions. As an entire Column of ſolid Oak, is heavier than an equal Column compoſed of ſeveral Pieces of Oak, Fir and Cork joined together.

AND this will in part explain the reaſon of the *Mercury*'s riſing and ſtanding high in fair, calm and clear; but ſubſiding and keeping low, in rainy, windy and cloudy Weather; becauſe in the former, the Preſſure of the *Air* is direct, uniform and ſteady; and in the latter, by the Interpoſure, or Fluctuation of Clouds and Vapours, broken and interrupted, and thereby in part diverted and diminiſhed.

THAT the Clouds floating in the *Air*, leſſen the Weight of it, ſeems to receive ſome Illuſtration at leaſt, if not Proof, from an Experiment or two delivered by Mr. *Boyle*.

TAKE a Piece of Spunge, moiſten it with as much Water as it will conveniently retain, without dropping. Suſpend it with a Weight equivalent to it, in a nice and even Ballance. While the Sun ſhines, and the Sky continues clear, the Scales will hang in *Æquilibrio*: But upon the Approach of any large Cloud towards the *Zenith*, the Water in the Spunge will preponderate, whilſt the Cloud is paſſing. But as ſoon as the Cloud is gone over, the very ſame State, or Preſſure of the *Air*, being again renewed, the Scales, in the Conſequence of it, will return back to their former *Æquilibrium*.

THIS, I am well aware of, the noble Author incidentally mentions, as a ſurprizing Effect, or ſenſible Indication of the Humidity, or Moiſture of the *Air*, derived from the tranſient Cloud, and communicated to the Spunge: But may it not ſeem alſo to deſerve our Attention, whether a real Change in the Weight of the *Air*, does not affect, or produce the Change in the Balance? Becauſe, agreeably to the Laws of Hydroſtatics, where two Bodies of unequal Bulk, are æquiponderant in one Medium,

dium, they will loſe their *Æquilibrium*, when they come to be weighed in another. For if this latter Medium be heavier, the larger Body will be ſupported in it, and weigh lighter than before; but if the new Medium be lighter, the more bulky Body will ſubſide in it, and weigh heavier than before. And accordingly the ſame noble Philoſopher, in what he calls his Statical *Baroſcope* (conſiſting of a thin large Glaſs Bubble, hanging in Counterpoiſe to a ſmall Glaſs Weight, in a Balance exquiſitely nice and ſenſible, and placed near a *Barometer)* regularly found; that when by any notable Encreaſe in the Weight of the *Air*, the *Mercury* roſe, the Glaſs Bubble would be buoyed up, and riſe with it: But when, by any conſiderable Decreaſe in the Weight of the *Air*, the *Mercury* fell; the Bubble would on the contrary preponderate, and fall with it.

From whence it appears, that the ſuperior Weight of the Spunge, in the Inſtance above-mentioned, ſeems rather to be derived from a ſenſible Decreaſe in the Weight of the *Air*. To thoſe who aſcribe it altogether to the Moiſture of the *Air*, without admitting any other Cauſe of it, it will be difficult to account for ſo odd a Property as that of a Spunge, ſucking in Vapours from an approaching Cloud, and releaſing them back, in exactly the ſame Quantity at the Receſs of it.

THE learned Dr. *Wallis* in his farther Sentiments upon this Subject, accounts for the gradual Sinking and Lowneſs of the *Barometer* in rainy Weather, by the gradual Diminution of the Preſſure of the *Air*, growing, as he ſuppoſes, lighter and lighter, in Proportion to the Quantity of the falling Rains.

IF this were ſtrictly and generally true; it will ſeem to follow from thence, that the Glaſs ſhould ſtand higheſt, when the *Air* is fulleſt of Clouds and Vapours; becauſe, (agreeably to this Opinion) it is then moſt burdened: And loweſt when the Rains are quite over, becauſe the *Air* is then moſt lightened.

BUT, on the contrary, we find by Experience, that the *Mercury* is uſually low in cloudy and rainy Weather, becauſe the *Atmoſphere* is then lighter: And may be often obſerved to riſe for ſeveral Hours before the Rains are over; becauſe there is a conſtant and gradual Acceſſion of new *Air*, pouring in to ſupply the Place of the deſcending Clouds and Vapours; and thereby encreaſing the Preſſure upon the *Barometer*, even whilſt the Rains are falling.

I WOULD not here be underſtood to infer from hence, that this Opinion of Dr. *Wallis* is altogether falſe; but that it does not, in all Caſes, hold abſolutely true. When the Regions above are calm, and at the ſame time crouded and accumulated with Clouds, diſcharging themſelves in heavy and plentiful Rains, the Quantity falling, will, it is reaſonable to imagine, in ſome Degree, leſſen the Preſſure of the *Atmoſphere*: Becauſe, by the Interpoſure of large and bulky Clouds, the free Influx of the circumambient *Air*, is, in ſome meaſure, and for ſome time, intercepted and excluded. But when the Communication is open, and the Clouds broken, or diſſipated, the free and regular Acceſſion of new *Air*, will add more to the Preſſure upon the ſtagnant *Mercury*, than the falling Rains detract from it.

And though in great and violent Rains, the ſeveral Drops of Water, being much heavier than the *Air*, force their Deſcent with ſome Degree of Rapidity through it: Yet can their Weight be of no manner of Effect towards raiſing the *Mercury*; becauſe they act not in one continued Stream, or Fall of Water, but in ſo many diſtinct and ſeparate Drops; each of which being at the largeſt not more than one fourth part of an Inch Diameter, bears but a very ſmall Proportion to a Cylinder of *Air*, better than five Miles in Height; and cannot therefore produce any ſenſible Alteration in it.

10. The higheſt Riſe and the loweſt Fall of the *Mercury* are but ſeldom obſerve-

able. The latter; becauſe it rarely happens, that a Hurricane exerts its Force near enough to a *Barometer* to affect it: And more rarely ſtill, that, during the ſhort Interval of its Action, the Eye of a Spectator is preſent, and quick and vigilant enough to obſerve it. And as for the more ordinary Ebb, as low as 28, and ſometimes a little below 28 Inches, it is uſually obſerveable, when the *Atmoſphere* appears to be crouded with bulky accumulated Clouds; and thoſe driving low, with a ſtrong Wind and ſlopping Rains, out of the *South*, or *Weſt*, or *South-Weſt*. But in a dry, cold Wind, unleſs it be very tempeſtuous, it is ſeldom found to ſink ſo low.

THE higheſt Riſe muſt, in like manner, be aſcribed to a Concurrence of ſeveral Cauſes, *viz.* To a ſettled *Eaſt* Wind, blowing Cold, to condenſe the *Air*; (which, by the way, is the Reaſon of the *Glaſs* riſing and ſtanding higher in the Winter, than in the Summer Seaſon) to a *Weſt* Wind, blowing at the ſame Time with equal Strength, to accumulate the *Air*; to a perfect Stillneſs and Calmneſs over the Place of Obſervation, to give the *Atmoſphere* its full perpendicular Preſſure; and to the Suſpenſion of the Vapours in the *Air*, lying in miſty and hazy Weather, with a ſtill farther additional Weight upon it. And to theſe we may probably join, what Mr. *Boyle* with Reaſon ſuggeſts, that in very great Droughts, the ſubterraneous Steams break out, and riſe in greater Quantities through the Chinks and Fiſſures of the Earth: Many of which, being lodged in the lower Regions of the *Air*, may, to a greater Degree, augment the Gravity of it. For as each of theſe ſeparately acting, are found by Experience to raiſe the *Mercury*; they muſt conſequently have the greateſt Effect, when all of them (as it may ſometimes happen) conſpire together in encreaſing the Preſſure of the *Atmoſphere*, and elevating the *Mercury* in conſequence of it.

11. IN remarking theſe Extremes, as well as in aſcertaining the juſt and preciſe Limits to the Riſe and Fall of the *Mercury*; the Situation of the Place where the *Barometer* ſtands, muſt always with due Care be conſidered and regarded. If it be low, and near the Level of the Sea, it will vary three Inches; becauſe the *Atmoſphere* above is of competent Weight and Depth to admit of it: If it be mountainous and far within Land, the *Mercury* will not vary two Inches; becauſe the Cylinders of the *Air* above are proportionably lighter and ſhorter. And, agreeably to this, it is found by Experience in ſeveral Places, that the very ſame *Barometer*, ſtanding at Fair in the Valley below, will, in advancing up to the Top of a Mountain, ſink to Stormy, though the Weather be exactly the ſame in both.

FROM whence we may collect and diſcover what an egregious Blunder it is in mechanical Philoſophy to appropriate the ſame Scale of the *Barometer*, without Diſtinction to all Situations. For as the Truth of the Scale depends upon the Proportion it bears to the full Play of the *Mercury*; and that in different Places, varies according to the different Height, or Depth, of the *Atmoſphere*: It is certain, that a graduated Plate of three Inches, cannot be commenſurate to a Space, or Riſe, of two Inches; but muſt and will be liable to continual Errors, by ſuch an Inconſiſtency in the Application.

UPON Account of this local Error and Inſufficiency in the common upright Tubes, I would recommend the ſloping *Barometers*, as more proper and ſuitable to the midland Countries; becauſe in them, the Riſe and Fall of the *Mercury* may be augmented to any requiſite Proportion, though the perpendicular Variation be not ſo much as two Inches.

THE foregoing Pages, grounded in a good meaſure upon Reaſon and Experience, ſeem to be a full Proof of the Truth of the main Propoſitions there advanced, *viz.* That the general Preſſure of the *Atmoſphere* upon the ſtagnant *Mercury*, is the real Cauſe of the Support of the *Mercury* in the Tube; that the ſeveral Changes in the Riſe and Fall of the *Mercury*, depend upon the various Changes in the Gravitation of the *Air*; and thoſe again upon the Quantity of Clouds and Vapours floating above; and upon the different Quarters, Degrees, Temper, and Oppoſition of the Winds.

AND though I dare not ſay that all the Changes of the *Barometer*, depending upon thoſe of the *Atmoſphere*, are clearly accountable for by theſe Principles; yet they certainly anſwer in ſo many Inſtances, that a ſtricter Attention to them, and Application of them, might perhaps go a great way in explaining thoſe few of which, by their ſeeming Inconſiſtency, or Irregularity, we find Reaſon to be diffident.

THUS I have ſometimes wondered at the *Mercury* riſing in a warm, moiſt *Southerly* Wind; but after a few Hours Suſpenſe, an *Eaſt*, or *Northerly* Wind, driving above, has prevailed over the *South* Wind below, and reconciled the Riſe of the *Glaſs*, to the Weight of the *Air*, and the State of the Weather. Sometimes alſo, in the like Caſe, when there has been no ſuch apparent Oppoſition of Winds, I have ſuſpected, either the Spring of the *Air* exerting itſelf in a more than ordinary manner; or that the Upper Regions of the *Atmoſphere*, being more cold and condenſed, have diſcharged their Weight upon the lower; and thereby cauſed the Riſe of the *Mercury*, though the warm rarefied *Air* near the Surface of the

Earth, ſeemed rather to intimate its Falling.

And here I might with Reaſon, as it was once my Intention, diſmiſs the Reader, with this general Theory of the *Barometer*, without deſcending to Particulars, or engaging in any farther Diſquiſitions about it: But ſince the Spring of the *Air*, has, no doubt, a real Share in producing the Effects here accounted for, it would be too material an Omiſſion to paſs it over in Silence, without taking a juſt and proper Notice of it.

As the *Air* is an elaſtic Fluid, capable (as we above obſerved) of Compreſſion and Dilatation; ſometimes yielding and bending beneath the incumbent Preſſure, and again riſing and expanding itſelf in proportion to the Abatement of it: So the chief Uſe and Effect of this elaſtic Property ſeems to be this, *viz.* To preſerve the Balance of the *Atmoſphere*; and by its occaſional Contraction and Expanſion, to accommodate itſelf to the different Degrees of Preſſure in the ſeveral Parts of it; and thereby, as well to keep the *Air* itſelf, as the Clouds and Vapours floating in it, as near as may be to an *Æquilibrium*.

To this elaſtic Force of the *Air*, ſome Authors (too precipitate in their Concluſions) have entirely aſcribed the Riſe and Fall of the *Mercury* in the *Barometer*; but it is very certain, without any juſt Premiſes, or competent Grounds for it. Becauſe in the regular and ordinary Courſe of Nature, the Spring of the *Air* acts always in Conjunction with the Weight of the *Air*, and never ſeparately, or diſtinctly from it: That therefore cannot of itſelf be the only Cauſe of an Effect, which requires and admits of another Cauſe equally co-efficient with it. Others therefore, more agreeably to Reaſon and Experience, divide the Effects of the *Barometer*, betwixt the Spring of the *Air*, and the Weight of the *Air*; and, without rejecting either, admit them both as Cauſes equally and mutually co-operating in them.

THE Spring of the *Air*, acts, it muſt be owned, with incredible Force, where the *Air* is cloſely pent up and ſtrongly compreſſed. But where the *Air* is free, open and unconfined, and has room on all Sides to expand itſelf, the Spring of it will be proportionably relaxed, and incapable of exerting itſelf with any notable Strength, or Effect. For the ſame Reaſon alſo, the Spring of the *Air*, near the Surface of the Earth, is very great, becauſe the Weight of the *Air* that keeps it under a State of Compreſſion, is great too: But in the upper Regions of the *Air*, where there is little Weight, and large Expanſion, the Spring of the *Air* is ſo far weakened and abated, that in an Aſcent of 1300 Yards perpendicular, the *Mercury* in the *Barome-*

ter is found, by Experience, to fall four Inches. Which in Part ſhews the Connection there is betwixt the Weight of the *Air* and the Spring of the *Air*; and that the latter depends, in a great meaſure, upon the former, as will more fully appear from the following Experiments.

THE moſt common and obvious Experiment, for proving the Spring of the *Air*, and the Dependance it has upon the Weight of the *Air*, is that of a Bladder half-blown, and carried up to a Mountain, to the perpendicular Height of 700, or 800 Yards; which, in Proportion as you riſe higher, will gradually diſtend more and more, and be full blown at the Top. And, in the Deſcent, it will, in like manner, gradually relax and ſubſide, and grow flaccid at the Bottom of the Hill, as before. The Reaſon of which is, that the *Air* encloſed and tied up in the Bladder below, is of greater Weight and Denſity (becauſe more compreſſed) than that above. When therefore, in mounting upwards, the Cylinders of the *Air* grow ſhorter and lighter; that within the Bladder muſt conſequently rarefy and expand itſelf into a larger Space, that the Attenuation of the *Air* within the Bladder, may be equal to that without. As on the contrary, when in deſcending downwards the Cylinders of *Air* increaſe in Length and Weight, that within the Bladder muſt conſequently ſhrink and contract within a narrower Compaſs, that the Denſity of the *Air* within the Bladder, may be anſwerable to the Preſſure of the *Air* without.

In the Experiment of the *Barometer* in the *Air*-Pump, (above recited, Page 20, Line 3.) if, inſtead of gradually admitting the external *Air*, you ſuddenly turn the Stop-Cock, and let it all at once into the exhauſted Receiver, the Quickſilver from its loweſt Ebb, will immediately dart up with that Degree of Force and Velocity, as even ſometimes to break the upper Extremity of the Tube: But if the Tube be ſtrong enough to ſtand the Shock, and wide enough to give the Quickſilver Play, it will then, for ſome little Time, vibrate upwards and downwards, 'till it ſettle to its proper Station. In this caſe, the ſudden Riſe of the *Mercury*, as well as the repeated Vibrations of it, above and below the Standard, are plainly produced by the Spring of the *Air*; but then, the regular and ſteady Settlement of the *Mercury* to its proper Standard, is certainly owing to a Cauſe equally ſteady and regular; that of the perpendicular Weight and Preſſure of the *Air* acting upon it, and by Degrees checking the Vibrations cauſed by the Spring of the *Air*, till they come to an *Æquilibrium*.

If we purſue this Experiment ſtill farther, with a Tube open at both Ends and ſuſpended in the ſtagnant *Mercury*; the *Mercury* will remain at the ſame Height in the

Tube, and in the Ciſtern. Then fix a cloſe Cover, as well round the Tube, as over the Top of the Ciſtern; and confining there, within the covered Space, a ſmall Quantity of common *Air*, (without any Communication with the external *Air)* and place the whole *Apparatus*, thus ordered, in the *Air*-Pump. The Effect will be this; that by working the Pump, and exhauſting the Receiver, the Counter-Preſſure of the external *Air* will be quite taken off; and then, the *Air* encloſed within the covered Ciſtern, will dilate and expand itſelf; and, by its elaſtic Preſſure upon the ſtagnant *Mercury*, will raiſe and force it up within the Tube, to the Height of 28 $\frac{1}{2}$, or 29 Inches, according to the Standard of the *Barometer* in the open *Air*, but no higher.

FROM hence it is evident; 1*ſt*, That the Weight of the *Air*, is here entirely ſeparated from the Spring of the *Air*; and the whole Effect produced by the latter. 2*d*, That the Spring of the *Air* encloſed, is equal to the Weight of the open *Air*, and acts only in Proportion to it. And 3*d*, That it is only the Confinement of the *Air* within the Ciſtern, and the Suſpenſion of the outward Preſſure, that cauſes the Spring of the *Air* to exert itſelf in ſo peculiar a Manner; which, in other Caſes, acts uniformly with the Preſſure of the *Air*, and ſeldom, or never diſtinctly from it.

THE ſame Effect is equally capable of being produced by encreaſing the Spring of the *Air* by any natural, or artificial Heat; but then in order to it, it is ſtill neceſſary that the *Air* ſo expanding itſelf, be ſome way, or other, ſhut up and confined: For if the Communication be open, the circumambient *Air* will ruſh in, and deſtroy the Spring acquired by ſuch Heat, by reſtoring the rarefied *Air* to its mean Temper and Denſity.

FROM theſe, or the like Remarks of the Spring of the *Air* encloſed, acting in ſuch particular Caſes, in Proportion to the Weight of the open *Air*, ſome unattentive Obſervers of Nature have credulouſly received, and unaccountably formed this general, but erroneous Concluſion, *viz.* That a *Weather-Glaſs*, hermetically ſealed at both Ends, with a ſmall Quantity of common *Air* encloſed in it, will, by its inherent Spring exerting itſelf, regularly produce the ſame Changes in the Riſe and Fall of the *Mercury*, as are correſpondent to thoſe of a *Barometer*, expoſed to the Preſſure of the open *Air*.

THE Experiment I have tried with a ſlender re-curve Tube, turning upwards at the lower End, and there ſwelling out into a larger Cavity, for the Reception of the common *Air*, and ſtagnant *Mercury*, encloſed within; which were nearly equal in Quantity, and might amount to about a cubical

Inch of each: But after a full Year's Obſervation, I could never find the Effect to any Degree anſwerable; nor diſcover any other Changes in it, than the Riſe and Fall of the *Mercury* about one fourth Part of an Inch; which might poſſibly be occaſioned by the Condenſation of the *Air* encloſed in cold, and the Rarefaction of it in hot Weather. But as for thoſe ſudden and greater Changes in ſerene and calm, in rainy and tempeſtuous Weather, amounting ſometimes in 48 Hours to near three Inches; the ſealed *Glaſs* (having no Communication with the outward *Air)* appeared to be inſenſible of them, and little, or no ways affected by either.

It ſeems therefore very probable, that the Opinion we are here arguing againſt, may have taken its Riſe from ſome Inadvertency in ſealing the Tube; and that, inſtead of being perfectly cloſed up, it might poſſibly have ſome little unheeded Aperture left in it; through which, the Communication with the external *Air* might be kept open and preſerved. For, without that, it is ſcarce poſſible to conceive, how a cubical Inch of common *Air)* (lying under an equal and ſteady Preſſure, having no Communication with the outward *Air* to produce any Change in it, no extraordinary Rarefaction, or Condenſation, to encreaſe its Spring) ſhould of itſelf exert a Force ſufficient to raiſe and ſupport a cubical Inch of Quickſilver; whoſe comparative Denſity to that of *Air*, is at the leaſt as 11500 to 1, or as others more accurately ſtate the Proportion, as 14000 to 1$\frac{1}{4}$.

To explain the Force of this Argument in a more familiar intelligible Manner; let us, in a Pair of Scales, place a ſingle Feather in Counterpoiſe to a Pound Weight; let us add afterwards 50 or 100 more to the Tale of Feathers; and it will be ridiculous to expect any ſenſible Effect, either from the one, or from the other: But if we encreaſe the Number to Ten, or Twelve Thouſand, they will then, perhaps be equivalent to the Weight, or turn the Balance the other way. Agreeably to ſo great a Diſproportion, a Cylinder of Quickſilver of 30 Inches in Length, requires (as we have proved above) a proportionable Cylinder of *Air* of more than 5 Miles in Height; and that too acting jointly with its Spring and Weight upon it, to raiſe and keep it ſuſpended in *Æquilibrio*; from whence it will conſequently follow, that ſo ſmall a Quantity of *Air* as the Ciſtern of a *Barometer* ordinarily contains (whether it acts by its Spring, or Weight, or both together) muſt be a Cauſe altogether unequal to the ſame Effect. *i.e.* in other Words, 2 or 3 cubical Inches of common *Air*, acting in a natural Way, cannot be ſufficient to produce an Effect, which, in the very ſame natural Way, is found by Experience to require near 12000 times a greater Quantity to produce it.

In the marine *Barometer* indeed, where the Spring of the *Air* encloſed, or rather its Rarefaction and Condenſation (as in a *Thermometer)* acts only upon the fineſt volatile Spirits; the Riſe and Fall of the tinged Liquor in the Tubes, is, it muſt be owned, greater than in a common *Weather-Glaſs*; becauſe both the *Air* encloſed, and the Spirits encloſed, are alike capable of Dilatation and Contraction; but when the Spring of the *Air* encloſed, is to act upon Quickſilver, upon a Fluid ſo vaſtly ſuperior to it in Weight and Denſity, the Effect of it, where the Quantities are ſo nearly equal, as in a ſealed *Barometer*, muſt be very little, if at all perceivable.

I have dwelt the longer upon this Property of the *Air*, as well to prevent and remove ſuch Objections, as have occaſionally fallen in my Way, as to diſentangle the intricate Part of this Subject, and place it, as near as I can, in a juſt and clear Light. In order to which, we may recollect in general, as the Reſult of the foregoing Paragraphs, that although the Spring of the *Air* (under a State of Confinement) may be artificially contrived ſo, as to raiſe the *Mercury* by its own Expanſion; yet the natural, regular and conſtant Effect of ſupporting the *Mercury* at its proper Height (in the open *Air)* ſeems more juſtly to be aſcribed to the Weight of it: Or rather, ſtrictly and philoſophically ſpeaking, to the Spring of the

Air, and the Weight of the *Air*, ſettling into a mutual *Æquilibrium*, and acting jointly and equally upon the *Barometer*.

It is indeed, with ſome Art and Difficulty practicable, to diſunite theſe two Properties, and divide them aſunder; but in the conſtant Operations of Nature, they are inſeparable. The Spring of the *Air*, acting always in Conjunction with the Weight of the *Air*, and in proportion to it. For when the *Air* is heavy, its elaſtic Particles being more compreſſed, they will conſequently expand themſelves with the greater Force; and, by ſuch additional Weight and Spring, will raiſe the *Mercury* very high. Whereas, on the contrary, when the *Air* is light, the Spring of it will be to a greater Degree relaxed and unbent; and conſequently, operating with a weaker Force, the *Mercury*, by ſuch a double Abatement of the Preſſure upon it, will ſubſide very low. And thus, in Proportion, as the Weight of the *Air* is greater, or leſſer, the Spring of the *Air* will be ſtronger, or weaker; and the Effect (whatever it be) will be jointly and equally the Product of both.

But if we ſtrictly conſider the particular manner in which the Spring of the *Air* operates; and that it raiſes and ſupports the *Mercury*, in the Tube, only by exerting a perpendicular Preſſure upon the ſtagnant *Mercury*; it is very certain, that by ſuch a direct Preſſure, it neither does, nor can act any otherwiſe than as an elaſtic Weight incumbent upon it; and, conſequently, that in this very Caſe, the Spring of the *Air* is ſo entirely co-incident with the Weight of the *Air*, as not to be either in Notion, or Fact, diſtinguiſhable from it. For which Reaſon, as well as to avoid any Perplexity in the Argument, I have all along in the main Part of this Diſcourſe, conſidered and aſſigned, the general Weight, or Preſſure, of the *Air*, as the only Cauſe of the Elevation and Depreſſion of the *Mercury*, without taking any other than a tranſient Notice of the Spring of the *Air*, contributing jointly towards it. For though it may, and muſt, in Strictneſs, be admitted as a partial, or concurrent Cauſe; yet, ſince it acts only in proportion to the Weight of the *Air*, and in Subordination to it; That, in the Balance of Reaſon, muſt be adjudged and accounted as the more general and ſuperior Cauſe; by its including, limiting and regulating the other (ſo far as this Subject is concerned) in its Effects and Operations. To thoſe who require farther Satisfaction upon this Head; and after what manner the Spring of the *Air* is reſolveable into the Weight of the *Air*, and operates by it, I recommend and refer them to *Nieuentyt's Religious Philoſopher*, Vol. 1. Pag. 190, to 194. which, beſides the good and uſeful Deſign of the Book itſelf, is a very valuable and compleat Syſtem of Mathematical, Mechanical, and Experimental Philoſophy.

BEFORE I diſmiſs this Article, I muſt not be ſo partial to what has been ſaid above, as to conceal from the Reader, that two or three Authors of ſome Note, have occaſionally advanced Poſitions very different from that Side of the Queſtion; which I have here undertaken to prove and explain: But as their Notions, upon this Subject, are, in the main, very obſcure and confuſed, and neither rightly conſiſtent, nor intelligible, I ſhall not trouble the Reader with any Recital, or Refutation of them; but leave the Learned in Speculations of this Kind, to compare and examine, to judge and determine according to what they find moſt agreeable to the Laws of Nature and Reaſon; and either to acquieſce in the plain mechanical Account here given; or, if they diſſent from it, to propoſe and ſubſtitute a better in its ſtead.

THE Account here given, I call plain and mechanical, becauſe a *Barometer*, ſtrictly conſidered, is, in Truth, nothing elſe but a Philoſophical Pair of Scales, wherein (by the artful Contrivance of a *Vacuum*, and the reſtleſs Endeavours of Nature to reſtore and preſerve an *Æquilibrium)* a Column of *Air* is continually weighing againſt a Column of Quickſilver. And, as for the various Changes in the Gravitation of the *Atmoſphere* (whatever Cauſes they proceed from)

from) they are, in a Philoſophical Eſtimate, to be conſidered no otherwiſe than as ſo many volatile Weights, which, to keep the Balance even, the Winds are continually ſhifting and playing out of one Scale into the other.

From hence it readily and naturally follows, that, by taking a preciſe Eſtimate of the Weight of the Quickſilver ſupported in the Tube, we are enabled to form a Judgment equally true, of the real Weight of a proportionable Cylinder of *Air*, riſing and reaching up to the utmoſt Height of the *Atmoſphere*; becauſe they are both ſuſpended in an even Balance, and the one is the exact Counterpoiſe to the other. From hence alſo, as well as from the general Purport of this Diſcourſe, neither the Writer, nor Reader, can well avoid drawing one very obvious Concluſion, of near Affinity with this Subject, and capable of undeniable Proof from it, And that is,

If in a common *Barometer*, the Preſſure of the *Air* be equal in Weight to 30 Inches of Quickſilver; then it will follow, that in Proportion as a Column of *Air* encreaſes in its Baſe, or Dimenſions, the Weight of it muſt encreaſe too: And, conſequently, as much as an human Body exceeds in Bulk the Dimenſions of a *Weather-Glaſs*, ſo much the greater Degree of Preſſure, from the incumbent *Atmoſphere*, muſt it ſuſtain.

To

To reduce this to Calculation. It is found by Experience, that a cubical Inch of Quickſilver weighs 3580 Grains. Let us then ſuppoſe the Body of a Man in an erect Poſture, taking one Part with another, to be commenſurate to a Square of 12 Inches: And from thence it will follow, that the perpendicular Preſſure of ſuch a Column of *Air*, upon the Head, Shoulders, and other prominent Parts of the Body, is equal in Weight to 2685 Pounds.

Let us ſuppoſe again the very ſame Perſon, lying, or extended upon the Ground; and the ſuperficial Meaſure of his Body, expoſed to the perpendicular Preſſure of the *Air*, to be four ſquare Feet: Then it is evident the Weight will be Quadruple, or equal to 10,740 Pounds.

If we purſue theſe Computations ſtill farther, by adding the lateral, or circumambient Preſſure, which is, at the leaſt, double to the latter Sum; then the whole Amount both of the lateral and perpendicular Preſſure of the *Air*, upon the Body of a Man of a very moderate Size, will be equal to 21,480 Pounds Weight.

This, and more than all this, were we to be ſtrictly nice in our Calculations, is clearly demonſtrable: But then, at the ſame Time, it is equally certain, that whether we ſtand upright, or lie down, or whatever Situation we may be in, we are not ſenſible of the leaſt Weight bearing upon us, or any Side, or in one Poſture more than another.

The Reaſon of which is, becauſe the Preſſure of the *Atmoſphere*, both above us, and below us, and around about us, is exactly balanced; and by the Spring, or Elaſticity of the *Air*, is continually kept and preſerved in ſo juſt and ſteady an *Æquilibrium*, that amidſt ſuch a dreadful Counterpoiſe of Weights (ſufficient to cruſh us into Atoms) we move and act with the ſame Freedom, Eaſe and Safety, as if we lived in a Space void of Matter, incapable of making any Reſiſtance to us, or of exerting any ſenſible Preſſure upon us.

To make this more eaſy and intelligible, let us put equal Weights into oppoſite Scales, ſo as to keep them ſuſpended in *Æquilibrio*, and then whether the Weights be a Thouſand, or Ten Thouſand Pounds each, they will be moveable with eaſe, and manageable at Pleaſure: nor can they, whilſt they continue thus *Æquiponderant*, affect us with any Degree of Preſſure, becauſe their Action, and Re-Action, being equal and oppoſite, the one will entirely deſtroy the Effects of the other; and leave no Superiority of Weight, or Motion, in either.

But if we deſtroy the *Æquilibrium*, by diminiſhing the Weight, or quite emptying one Scale; the other will then inſtantly deſcend, and act with a Degree of Force and Velocity, anſwerable to the Superiority of Weight in it.

Thus, whatever the Preſſure of the *Atmoſphere* may be, ſo long as the Balance of it, on every ſide, is ſtrictly preſerved, we feel no Weight, we ſuffer no Violence, we fear no Danger from it: But if the Equality of its Preſſure be deſtroyed, as it ſometimes is, either by a ſudden Flaſh of Lightening, or Exploſion of Gunpowder, the Effects of it then will be ſurprizingly great and terrible; and the Weight and Spring of the *Air* (let looſe thereby) will exert themſelves with ſuch incredible Force and Velocity, that nothing can withſtand them; and the ſtrongeſt Buildings we can raiſe for our Security, are, in a Moment, liable to be laid level with the Ground by them.

For, agreeably to the Calculation above recited, the perpendicular Preſſure of the *Air* upon a Room no larger than 12 Feet ſquare, is equal in Weight to 386,640 Pounds. And the lateral Preſſure (conſidering it only as quadruple) is equal to 1,546,560 Pounds. So that whether the one, or the other of theſe prodigious Weights, acts ſeparately, or both of them together, with a Degree of Velocity, anſwerable to that of the Spring of the *Air*, ſuddenly exerting itſelf, it is very certain, that the Force muſt be abundantly greater, and the Shock more violent, than any Work of human Structure can have Strength, or Firmneſs, ſufficient to ſuſtain.

THESE Computations of the Weight of the *Air*, grounded upon the Weight of a cubical Inch of Quickſilver, do, it muſt be owned, far exceed others, relating to the ſame Subject, drawn up in the Sequel of this Diſcourſe; becauſe herein the Station of the *Barometer* is taken at 30 Inches; as in the others, at a lower Rate. But if we adhere to the ſame Height of the *Mercury*, and eſtimate the Weight of a cubical Foot of Water (as Dr. *Halley* does in his Calculation of the Quantity of Vapours elevated) at 76 Pounds; the two Accounts will be nearly equal; and the Difference betwixt them not very material.

FROM theſe Speculations, it is evident, that the *Air* is very far from being a Body ſpecifically light, as we are ſome of us apt to imagine, and the Philoſophers, of former Ages, generally held: and that the modern Diſcoveries of its Gravitation, at the ſame Time that they improve our Knowledge, alarm us of unexpected Danger from it: It being certain (whether we will believe, or conſider it, or not) that we have every Moment of our Lives, the moſt formidable Weights hanging over us, and ſurrounding us on every Side; Weights, if they were permitted to operate with their full Force, ſufficient, not only to deſtroy us, and every living Creature, but all the Works of human Art and Induſtry; all the outward Furniture of the Globe together with them. But then, as the Hand of Providence holds the Balance; and by Laws, peculiar to them, reſtrains theſe terrible Powers of the *Air* from breaking out with their natural Force and Strength upon us, we are ſecure in the midſt of the neareſt and greateſt Dangers: And ought, with Thankfulneſs, to acknowledge, as we with Safety and Pleaſure enjoy the Benefits of ſo wonderful a Fluid (in Seeing, Hearing, Talking, Moving and Breathing in it) without feeling, or dreading any fatal, or violent Effects from it. Thoſe Perſons who are deſirous of farther Conviction, or Satisfaction upon this Article, I refer them to the excellent Author above-mentioned, *viz.* Dr. *Nieuentyt*'s *Rel. Philoſopher.* Vol. I. Page 194, *&c.* to the End of the Section.

To what has been ſaid above, upon the various Streams and Weight of the *Air*, upon the Riſe of the Vapours, the Suſpenſion of the Clouds, *&c.* I ſhall here, by way of Supplement, add what has occurred to me in the Courſe of my farther Speculations upon the ſame Subjects: To have inſerted them ſooner, muſt have interrupted the Thread of my Diſcourſe, and cauſed too large a Digreſſion from it; and not to inſert them at all, would, in Effect, be to leave the Theory of the *Atmoſphere* (upon which the State of the Weather, and the

Motions of the *Barometer* ſo much depend) to a great Degree imperfect without them.

1. As the *Atmoſphere*, or Body of groſſer *Air* ſurrounding the Globe, riſes and reaches (as we have proved above) more than five Miles in Height; and, by a moderate Computation, contains above 2000 Millions of cubical Miles, there is evidently room ſufficient in ſo expanſive a Fluid, for the Reception and Diſtribution, for the Diſſipation, or Collection, of all Kinds of Vapours and Exhalations, which are raiſed, or forced up, either by the ſolar, or ſubterranean Heat, from all Parts of the Surface of the Sea, or Earth.

To what Height the Vapours aſcend, does, in a great meaſure, (as we have already in Part intimated) depend upon the Degree of Heat, wherewith they are actuated and diſtended, and upon the Fineſſe and Lightneſs of the Vapours themſelves, upon the Denſity of the *Air* wherein they are buoyed up; and even ſometimes upon the Strength and Force of the Winds wherewith they are impelled. Some of them are ſo far ſubtilized and attenuated, and riſe to ſo great a Height, as not to be diſtinctly viſible; of which Kind, in Sir *Iſaac Newton*'s Opinion, are thoſe that form by Refraction the blue, or azure Colour of the Sky. Other Vapours of a groſſer Kind, being compacted into Clouds, and keeping for ſome Time a fixed Station in the Regions above, have (as Mr. *Boyle* tells us) been ordinarily meaſured to the Height of one fourth, or one third Part of a Mile; and ſome to half a Mile: But that very few, and thoſe of the whiteſt, and in Appearance, the loftieſt Clouds, were, upon Tryal, found to be above three Quarters of a Mile in Height.

BUT herein the Accounts of foreign Mathematicians widely differ: Not that the ordinary Floats of Clouds in *France*, or *Italy*, are, in reality, doubly or trebly higher than ours; but that ſuch remarkable Clouds, whoſe perpendicular Heights were accurately taken and committed to Writing, have ſome of them, as they tell us, amounted to 2, 3, or even 4000 Geometrical Paces; but none of them have exceeded 5000 Paces, or 5 Miles in Height. Though in all Appearance, were Obſervations of this Kind more frequently made, the very ſame Heights of the Clouds, or perhaps greater, might be ſometimes diſcovered even here.

THE Day after the great Storm 1703, when all was ſtill and calm below, a Thunder Cloud of unuſual Height, and Swiftneſs of Motion, paſſed over *Oxford*, riſing out of the ſame Quarter, and moving in the ſame Direction with the late Storm: Which was not indeed meaſured by any that I remember; but was adjudged, by good Mathematicians upon Sight, to be at the leaſt five Miles in Height.

For, if the Storm itſelf (as it was then generally imagined) was the remaining Effort of a Hurricane from the Coaſts of *America*; if the Force wherewith the Cloud was impelled, was vaſtly ſuperior to that of its Gravitation: From thence it will follow, that the farther any ſuch Cloud moves on in a direct Courſe, or very little declining from a ſtraight Line, the higher muſt ſuch a Cloud riſe in its perpendicular Diſtance from the convex Surface of the Earth; and the leſs Reſiſtance it meets with from the upper Regions of the *Atmoſphere*, the ſwifter it will move. But when the protruſive Force of the Wind abates, and that of Gravitation prevails, the Cloud itſelf will acquire a Degree of Velocity from its extraordinary Height, and fall down, as this was obſerved to do, in violent Rain, or Hail.

And this will let us into the natural Reaſon of a vulgar Obſervation, *viz.* That in cloudy and ſtormy Weather, when the Wind falls, it will commonly rain, becauſe the Clouds are carried on by the Strength of the Wind, in a ſtraight Courſe to a greater Height, than the Denſity of the ſuperior Regions can ſupport: As ſoon therefore, as the Horizontal Impulſe ceaſes, the Clouds, by their own natural Gravity, muſt deſcend in Rain.

Such a moderate Height, as we have here aſſigned to ſuch of the Clouds as conſiſt of aqueous Exhalations, is accountable for in a natural Way; but the more extravagant Height, mentioned by Mr. *Boyle*, and cited from *Ricciolus*, ſeems to be hardly credible. That Author relates, that two ſkilful Aſtronomers, in their nocturnal Obſervations in *France* and *Italy*, viz. *Ab horâ undecimâ uſque ad mediam noctem, Lunâ infra Horizontem poſitâ, viderunt nubeculam quondam lucidam propè meridianum, fere uſque ad Zenith diffuſam; quæ conſideratis omnibus, non poterat niſi a Sole illuſtrari; ideoque altior eſſe debuit totâ umbrâ terræ.* i. e. They took notice of a Cloud, which appearing bright at Midnight, and being (as they concluded) enlightened by the Rays of the Sun, muſt, in their Judgment, have been higher, than the projected Shadow of the Earth.

BUT as the Shadow of the Earth (obſerveable in Eclipſes) reaches far beyond the Regions of the Moon, and there only terminates in a Cone, at the Diſtance of about 300,000 Miles; it is hardly credible, that a Body of ſo little Firmneſs and Conſiſtency as a Cloud, ſhould be capable of reflecting and tranſmitting Light from ſo immenſe a Diſtance: And it ſeems therefore a more rational Conjecture, that the particular Cloud deſcribed above, might rather be one of thoſe luminous Clouds, ſuperior to our *Atmoſphere)* (which we of late ſo often ſee riſing out of the *North*, and ſhining with their own native Light) than that it ſhould be any common, or extraordinary

Cloud, detached ſo far from the Body of the Earth, or Moon; and ſhining with derivative, or borrowed Light, from the Rays of the Sun.

THESE and the like luminous Clouds (conſiſting, as they are generally ſuppoſed, of ſulphureous and inflammable Vapours, and from thence deriving a natural Spring, or Levity, exerting itſelf in mounting upwards; for ſuch Vapours, actuated by Heat, will aſcend in *Vacuo Boileano*, without any Medium to ſupport them,) riſe to a very great Height, above the common Limits of our *Atmoſphere*. And ſuch of theſe Clouds, as, by their remarkable Appearances in very diſtant Places, have been reduceable to Calculation, have exceeded the Height of 40, 50, or even 60 Miles: Of which we have an Inſtance (*Phil. Tranſ.* Numb. 360. Page 984.) in that extraordinary Meteor of *March* 19, 1718, breaking out from a duſky Cloud, and computed by the learned and accurate Dr. *Halley*, to be in a round Number 69 Miles in perpendicular Height above the Surface of the Earth.

BUT as theſe bright and light Clouds make no Difference in the Weight of the *Air*, nor produce any Change in the *Barometer*, I ſhall paſs them by, as foreign to our Purpoſe, (as well as that more remarkable Cloud, obſerveable in the *Southern Hemiſphere*, and keeping a fixed Station and

Appear-

Appearance near the *South* Pole; which ſeems to be one of the Wonders, or Myſteries of Nature, lying without the Reach of human Imagination to form any rational, or even probable Conjecture about it) and return back to what bears a more immediate Relation to this Subject.

2. The *Atmoſphere* being (as we have remarked above) of ſo great Depth and Extent, and reſting with its whole incumbent Weight upon the Surface of the Earth, the general Preſſure reſulting from it, muſt be great in Proportion. Let us ſuppoſe a cubical Foot of Water, taking it at the loweſt, to weigh 63 (though ſome of our *Engliſh* Authors have rated it at 76) Pounds; and that the Weight of the *Air*, as is evident in a Pump, ordinarily ſupports a Column of Water 33 Feet in Height. From thence it will follow, that the general Preſſure of the *Atmoſphere*, is equal to that of an Ocean of Water ſurrounding the Globe 33 Feet in Depth. And, conſequently, that the *Atmoſphere* impendent over *England* (computing it in ſuperficial Meaſure to be 39 Millions of Acres) amounts to more than Fifteen Hundred Thouſand Millions of Tuns Weight, *viz.* 1,576,735,875,000 Tuns.

And ſince it is the Property of all Fluids, to raiſe and buoy up, all ſuch Bodies, which, Bulk for Bulk, are lighter than themſelves, lighter than the Medium in which they float: From hence alſo it will farther follow, that in an Ocean of *Air* of ſuch intrinſic Weight there muſt be a Counterpoiſe more than ſufficient, to ſupport a far greater Quantity of Clouds and Vapours, Rain, or Snow, *&c.* than the *Atmoſphere* ordinarily contains; and abundantly more, than at any one Time appears to be diſcharged from it.

By the celebrated Dr. *Halley*'s Calculations, the *Mediterranean* Sea, in a Summer's Day, exhales in Vapours at the leaſt 5280 Millions of Tuns; and the drying Winds, he farther adds, are ſometimes obſerved, to lick up an equal, or greater Quantity of Vapours from the Surface of the Water, than is exhaled by the Heat of the Sun. If therefore we ſuppoſe two or three ſuch drying Days to paſs, without any Fall of Dew, or Rain, to diminiſh the Quantity, there will be evidently raiſed up in Vapours, and ſupported at one Time in the neighbouring Regions of the *Atmoſphere*, above Thirty Thouſand Millions of Tuns of Water.

And, by this means, it is poſſible for ſome Parts of the *Atmoſphere*, to be ſometimes even ſaturated, or overcharged with Vapours; which, as they afterwards happen, either to be driven and diſperſed, or collected and accumulated by the Winds, will accordingly produce moderate, or plentiful Supplies of Rain, upon ſome Parts of the Continent, or exceſſive Quantities in others.

And from hence, in Appearance, are derived, as well the wet Seaſons, peculiar to ſome foreign Climates, as the greateſt Gluts of Rain, ſometimes incident to our own; which proceed always from ſuch a copious Exhalation of Vapours, and generally from ſuch a previous Confluence of Clouds, and Oppoſition of Winds, (as we have already in Part intimated) the latter, *viz.* the oppoſite, or contrary Winds, ſtill driving on, and bringing up freſh Supplies of Clouds and Vapours ranged on either Side; where (being checked in their farther horizontal Progreſs, and heaped up in greater Quantities than the *Air* can ſupport) they muſt conſequently ſtop, and, ſucceſſively condenſing, fall; much after the ſame manner, and in ſuch like Streams of Rain, as we ſometimes ſee pendent from the Clouds, and reaching down in continued Streaks, or Lines, towards the Surface of the Earth; which are always very violent, under, or near the Place of Concourſe, but ſeldom extend to any wide Circuit, or Tracts of Land.

The Reader will, I doubt not, readily excuſe a ſhort Digreſſion here, in taking notice of ſuch a mutual Approach, and dreadful Congreſs of two Thunder-Clouds, as it is nobly imagined and deſcribed by *Milton*;

—— *As when two black Clouds* [*on*
With Heav'n's Artill'ry fraught, come ratt'ling
Over the Caſpian; *then ſtand, front to front,*
Hov'ring awhile, 'till Winds the Signal blow
To join their dark Encounter in mid Air.

Eſpecially ſince theſe admirable Lines are here inſerted, not altogether for the Sake and Pertinence of the Deſcription, but with a View of grounding ſomething Philoſophical upon the ſame Thought, farther purſued. Let us then ſuppoſe theſe two Thunder-Clouds, thus moving in direct Oppoſition, to be very great, full charged with Vapours, and juſt upon the Point of falling: Let us farther imagine them to be driven with equal Strength by contrary Winds (as Thunder-Clouds are commonly obſerved to riſe againſt the Wind; which, by the way, is the Reaſon of their firſt Appearance, being always mountainous) and accordingly to meet and mix, to be blended and confuſed together; the very ſame Winds ſtill continuing to preſs them forwards towards the Place of their mutual Concourſe and Diſſolution: Let us once more ſuppoſe the ſubjacent Country to lie ſhelving, with a general, or double Declivity; and that, leading into a ſingle Valley, or Channel: From ſuch a real, or even partial Concurrence of Cauſes and Circumſtances, it is incredible to imagine, how great a Quantity of Rain ſuch a Concourſe of Clouds will appear to diſcharge, and what a prodigious Inundation it will raiſe; when the Waters falling thus within the Compaſs of ſuch a Declivity, are all collected together into one ſingle Current, and that confined within one narrow Paſſage, or Channel? And how impracticable it is, for any common Buildings, ſuch as Men raiſe for Convenience, rather than Strength, to bear up againſt a Torrent of Waters, rolling down all at once, with ſuch impetuous Weight and Force.

FROM theſe Premiſes, or ſomething of the like Nature, we may in a very probable manner, account for thoſe terrible Storms, as well as for thoſe great and ſudden Inundations, happening lately at *Sheffield* in 1729, at *Ripponden* in 1723, and another near *Madrid* in *Spain*, in 1725, or 1726; more tragical in the Number and Quality of the Perſons ſurprized and drowned in it, than either of the former: Towards which, ſuch a peculiar Confluence of Clouds, and unhappy Situation of the ſeveral Places, might, in all Appearance, contribute more, than any imaginary Land-Spouts, or Cataracts of Water pouring from above: which are uſually talked of, and ſometimes received as Matters of Fact, upon theſe Occaſions; though they are ſeldom, or never ſeen, or known in any inland Country, at ſo remote a Diſtance from the Sea.

3. It is frequently obſerved by Sailors in ſeveral Parts of the Ocean, that the upper, or viſible Current of the Water drives one Way, at the ſame Time, that an Under-current runs another Way; and ſometimes in Courſes directly contrary. Agreeably to which, as the Parts of the *Atmoſphere* are more eaſily ſeparable, than thoſe of Water, more capable of receiving any Impreſſion, and of propagating and continuing any Motion produced in them: It is certain that in ſo great a Depth of *Air*, as we have above aſſigned to it; there may, and muſt be often Variety of Streams, or Currents of *Air*, driving different Ways, in higher, or lower Regions of the *Atmoſphere*; ſometimes at ſo great a Diſtance aſunder, as to move freely without Interruption; and ſometimes in, or near the ſame Level, or Horizontal Planes, croſſing and interfering with each other in ſeveral different Courſes and Directions.

Let us, for Inſtance, allow $\frac{1}{2}$ or $\frac{1}{3}$ Part of a perpendicular Mile, for the Under-current of *Air*; and to the ſuperior Regions, and Streams of *Air* driving through them, allot the ſame Proportion. It is no uncommon Thing to find and feel a very ſtrong Wind below, whilſt the Clouds remain fixed and immoveable in their Station above, or, on the contrary, to ſee the Clouds driving with great Swiftneſs above, when all is calm and ſtill beſtow. Sometimes we may diſcover two diſtinct Squadrons of Clouds, floating at different Heights, in Streams of *Air* directly contrary; ſometimes an intertermediate Wind ariſing, by its ſuperior Strength, controuls and carries each of the other Currents along with it; or if they happen to be nearly equal, and neither of them extinguiſhed, we may often, in ſuch a Caſe, obſerve the Clouds to meet and mix, and to encreaſe all of a ſudden in Bulk and Quantity; being driven and collected together by ſuch a Complication of Winds blowing towards the ſame Regions of the *Atmoſphere* from different Quarters. And agreeably to this Purpoſe, in the very worſt of Weather, when it runs into either Extreme of Rains, or Snow, it is reaſonable to imagine that there is always the greateſt Confuſion in the Streams of *Air*, and Confluence of Clouds and Vapours above, when, by the Thickneſs of the *Atmoſphere*, we can diſcern the leaſt of it from below.

SINCE therefore the *Atmoſphere* is thus actually ſeparable into various Horizontal Planes; and thoſe (as it often happens) with different Streams of *Air*, and Squadrons of Clouds floating through them: From thence it will ſeemingly follow, not only that the Weight and Temper of it muſt be liable to frequent and ſudden Alterations; but that no regular, or certain Judgment can be formed of the general State and Quality of the *Atmoſphere*, without taking in the full Extent of it. Becauſe the Upper Regions of the *Air*, may be very different from the Lower in their Effects and Indications; nor can any Change of the Weather be laſting, where there is not a ſuitable Tendency in the whole *Atmoſphere* to ſupport and confirm it.

And, upon this Account, as the Weight of the *Atmoſphere* runs through the whole Extent of it; and is, in Truth, the chief Property concerned, as well in ſupporting the Clouds and Vapours, as in giving way, upon any Abatement, to their Deſcent in Rain: So the Motions of the *Barometer* depending, in like manner, upon the Weight of the whole *Atmoſphere* (riſing with the Encreaſe, and falling upon the Diminution of it) muſt be a more likely and reaſonable Preſage of the State of the Weather, than and of the common *Hygroſcopes*, or *Weather-Houſes*; which depend altogether upon the Moiſture, or Dryneſs of the *Air* near the Surface of the Earth, and (how myſterious or ludricrous ſoever ſome of them appear) conſiſt ordinarily of a twiſted Cord, or Gut; in damp Weather, ſwelling in Bulk, and thereby contracting in Length; or, on the contrary, when the *Air* is dry, ſhrinking in Bulk, and thereby extending in Length.

If therefore we ſuppoſe, as it ſometimes happens, the lower Region of the *Air* to be moiſt, when all above has a Tendency to be fair and dry; or the lower Region to be dry, when all above has a Tendency to wet Weather: It is certain, that no Conjecture, taken from Part of the *Atmoſphere*, can be ſo well grounded, as what is derived from the more general and prevailing Quality of the Whole.

NOT that, even in this latter Caſe, we can form any certain Judgment of a Thing ſo mutable as the ſucceeding State of the Weather: Becauſe the ſudden Changes and Oppoſitions of Winds, and Confuſion in the Streams of *Air* and Vapours driving above, are uſually attended with Changes equally ſudden and irregular, as well in the Motions of the *Barometer*, as in the Temper and Quality of the Weather. Within the ſhort Compaſs of 48 Hours, I have obſerved theſe following, (and it rarely happens, but that the like, or greater Changes in the Winter-Seaſon may be equally obſervable) *viz.* 1*ſt*, A warm Wind and Rain out of the *South*, the *Glaſs* near Stormy. 2*d*, A cold *North* Wind, the *Air* clear and froſty; the *Glaſs* betwixt Rain and Changeable. 3*d*, A cold *Southerly* Wind and Rain, for ſix or eight Hours; the *Glaſs* advancing ſtill towards Fair. 4*th*, A *Weſt* Wind riſing gently, and after ſome little Time blowing ſtronger, and clearing the *Hemiſphere*, the *Glaſs* in the Beginning at Fair, and afterwards ſinking to Changeable.

THE two former Articles are above accounted for; in the two latter (where the Difficulty and Irregularity lie) it ſeems very probable, that the very ſame Oppoſition of Winds, which in the lower Regions, by mixing and jumbling together the Clouds and Vapours, precipitated them in Rains; might, by heaping up and accumulating the *Air* above, cauſe a gradual Addition to the Weight of it; and thereby keep the *Barometer* riſing, even whilſt the Rains were falling. And as the *Weſt* Wind, as its firſt ſetting in with a gentle Gale, ſeems alſo to have added to the Accumulation, by the *Glaſs* ſtanding at Fair; ſo after it prevailed over the other Winds, and drove off the accumulated *Air* from the Place of Obſervation; the *Mercury* (by ſuch a Diminution of the Preſſure upon it) ſettled to Changeable.

FROM theſe, or the like inconſiſtent Effects and Appearances, it is obvious to remark, that a real Diſtinction may, and ought to be made, betwixt the *Barometer* and the *Weather-Glaſs*; the former always going right, as it is an Indication of the Weight of the *Air*; becauſe it is a regular and even Counterpoiſe to it, in the ſeveral Degrees and Changes of its Gravitation: But that the latter may, and does ſometimes remarkably err (as in the Inſtance above-mentioned) in the Indication of the Weather.

But then, as theſe extraordinary Oppoſitions of Winds, and Irregularities flowing from them, happen but ſeldom, and never laſt very long; they will not hinder, but that the Riſe and Fall of the *Mercury*, will, generally ſpeaking, be an uſeful Monitor and ſerviceable Direction to us, in other more regular, leiſurely and ſettled Alterations of the Weather.

From what has been here ſaid in Addition to the Theory of the *Atmoſphere*, it appears, that the Sun daily and actually raiſes from the Surface of the Ocean, a prodigious Quantity of watry Bubbles and Exhalations; which the lower Regions of the *Air*, by their Denſity receive, and tranſmitting upwards, ſuſtain at their proper Height. Theſe the Winds, or Streams of *Air*, moving above, variouſly tumble and toſs about; ſometimes ſcattering and diſperſing them in Regions far remote. And, at other Times, collecting and amaſſing them together in greater Quantities than the *Atmoſphere* can ſupport. And if to theſe Premiſes, we farther add, with the ingenious and learned Mr. *Derham*, the Coldneſs of the ſuperior Regions (condenſing and thickening the Coats of theſe watry Bubbles; and either freezing them above, or compacting them into ſolid Drops, and thereby encreaſing their Weight, and giving them a Tendency towards falling) from theſe and the foregoing Principles, and the different Action and Combination of theſe natural Cauſes; the various Changes in the Temper of the *Air*, the Unſteadineſs of the Weather, and the Irregularity of the Seaſons, are derived; and may, in a reaſonable manner, be deduced and explained.

4. THAT the Upper Regions of the *Atmoſphere* are actually cold, or comparatively colder than the Lower, was the received Opinion of *Ariſtotle* and the Naturaliſts of his Age; and ſeems to have been grounded upon the common and obvious Obſervation of Snow and Ice melting at the Foot and Sides of the higheſt Mountains, but lying undiſſolved, through all the Seaſons of the Year, at, or near the Tops of them. But from whence this Coldneſs of the ſuperior Regions proceeds, may deſerve our Enquiry.

AS there are Plenty of ſulphureous and inflammable Exhalations extracted by the Heat of the Sun from the Juices of Plants and Minerals; which (being raiſed up to a very great Height, and, by that natural Principle of Attraction, whereby Things of a ſimilar Nature run together, there collected in great Quantities, pent up within the Clouds, and fired by Fermentation) diſcharge themſelves in Lightening and Thunder: So on the contrary, it is equally certain, by Experience, that there are other volatile Particles, as well as ſeveral mineral Extractions and Compoſitions, of a Nature intenſely cold; which, where-ever they exert or extend their Effects, produce natural, or artificial Freezing.

Mr. *BOYLE* obſerves, that a Solution of Gunpowder in a due Proportion of Water, will produce a great and ſenſible Degree of Cold: And as Lightening in its Nature and Effects, bears the neareſt Reſemblance to Gunpowder; ſo it ſeems very probable, that the very ſame nitrous and ſulphureous Particles, which, when collected and compreſſed together in greater Quantities, break out into Flaſhes of Lightening; when they are more ſcattered and diſperſed, and mixed, or diſſolved in aqueous Exhalations, may produce the ſame Degree of Cold above, as they are, by Experience, found to cauſe below. From hence, however, in hot ſultry Weather, we may account for that agreeable refreſhing Coolneſs obſervable in the *Air*, after a Storm of Thunder and Lightening, *viz.* From the Solution of the nitrous and ſulphureous Vapours, whereof the Lightening conſiſts; many of which (being fired at every Flaſh, and quenched in their Deſcent through the Drops of Rain) remain floating in the lower Regions of the *Air*, and produce that grateful Refrigeration in the Lungs and Blood, of which we are moſt ſenſible, immediately after the ceaſing of the Storm. To this alſo may in Part be aſcribed the peculiar Chilneſs and Coldneſs of ſome of the Summer Winds and Rains; and even in the Winter Seaſon, the nitrous

Particles floating in the *Air* in froſty Weather, are by *Gaſſendus*, and other Philoſophers, held, to make the moſt ſenſible Addition to the Sharpneſs of it.

THIS, in Appearance, ſeems to be a partial Cauſe, contributing, in ſome meaſure, towards the Coldneſs of the middle Regions of the *Air*; but can by no means be admitted as an adequate, or ſufficient Cauſe for it. Let us therefore, beſide this, farther conſider, that as well under the *Southern*, as the *Northern* Pole; there are vaſt Tracts both of Sea and Land, covered with fixed, or floating Mountains of Ice, or unfathomable Depths of Snow; which have lain undiſſolved there for many Centuries, and, by the Obſervation of Sailors to *Greenland*, ſeem, in ſome Places, at leaſt, by the different Strata of Snow, to receive a yearly Encreaſe.

THESE then, as Cold naturally produces Cold, ſeem to be the great Magazines of Nature, from whence that Quality of the ſuperior Regions is derived and ſupplied: But how, or by what means, the Communication is carried on, will admit only of preſent Conjectures, 'till Time and Philoſophy make way for future Diſcoveries. Whether the Winds may contribute towards it, by blowing from the *North* and *South*, with greater Steadineſs and Conſtancy in the Regions above, than in thoſe below? Whether the Sun, keeping always within the Tropics, may not ſo far heat and attenuate the Tropical *Air*, as to draw in continual Supplies of colder and more condenſed *Air* from the polar Regions, to preſerve the Balance? Or whether the Moon, may not have the ſame Influence in raiſing a Tide, and continuing the Circulation of it, through the vaſt Ocean of *Air* above, as ſhe is found by Experience to cauſe in the ſeveral Oceans of Water here below? Or laſtly, whether the Communication betwixt the polar Regions, may not depend upon other Cauſes unknown to us; and as it is certain from the common Effects and Operations of the Loadſtone, that there is a continual Stream of magnetic Particles, flowing near the Surface of the Earth, and paſſing from Pole to Pole: So, whether there may not, in like manner, be ſomething analagous to it, paſſing through the middle Regions of the *Atmoſphere*, in a Stream of Vapours, or Particles, intenſely cold, and thereby anſwering the great Ends of Nature, in cooling the upper Regions of the *Air*, in giving a Check to the Riſe of the Vapours, in condenſing and precipitating many of them in Dews, or Rains, in forming the ſeveral Kinds of Meteors, in actuating and giving Force and Strength to the Winds, which, beſides other Cauſes, ſeem to depend, as well upon the frequent and ſudden Condenſations of the *Air* by Cold, as upon the Rarefaction of it by Heat; and to require the mutual and alternate Action and Re-action of both. (As Mr. *Derham's Phyſico Theology*, Note p. 15, 16. in part confirms and obſerves.)

AND agreeably to this Obſervation, the temperate Zones, being, by their Situation, liable to different Degrees and frequent Viciſſitudes of Heat and Cold, are, by Experience, found to be the chief and only Seat of the variable Winds: Whereas in the torrid and frigid Zones, the Degrees of Heat and Cold being more equal, conſtant and regular, thy Winds blowing within their reſpective Limits are ſo too.

BY the daily Revolution of the Earth upon its own Axis, the *Air* within the Tropics paſſing daily under the meridian Heat of the Sun, is to a great Degree rarefied and attenuated by it: In the Conſequence of which, the more cool and heavy *Air* preſſing in, to preſerve the Ballance; and following the apparent Motion of the Sun towards the *Weſt*, cauſes a general *Eaſt* Wind to blow round the Globe on each Side of the *Æquator*; which, being at all Seaſons of the Year nearly equal and conſtant, can produce little Alteration, either in the Weight of the *Air*, or the Riſe or Fall, of the *Mercury* within the Tropics.

THE very ſame Effect (of little or no Variation in the Height of the *Mercury)* equally follows from the intenſe and ſettled

Coldneſs of the polar Regions, whereby the *Air* above is to ſuch a Degree condenſed and continued in a State of Denſity, as even to reſiſt the Impreſſion of the Winds, and thereby prevent any notable Changes in its Gravitation. And agreeably to this Purpoſe, Mr. *Boyle,* from the Voyages to *Greenland,* &c. remarks; that the Mountains of Ice, in thoſe *Northern* Climates, by the extraordinary Weight, or Reſiſtance of the *Air* reſting upon them, give a certain and gradual Check to any ſuch diſtant Winds, as blow directly upon them; ſo as either to becalm the Ships, or render their Approaches very ſlow and leiſurely towards them.

But then, on the other Side, when any of theſe large Mountains, or Iſlands of Ice, are looſened from their Foundations, and ſail with the Current from the polar Regions, towards the Tropic; they are generally followed with a ſtrong *North,* or *Eaſterly* Wind, driving them forward; and as ſome of theſe are deſcribed by Travellers, as riſing in Height, and ſinking in Depth, from 50 to 140 Fathoms, and extending in Bulk and Circumference ſeveral Miles: It is certain, that ſuch a prodigious Accretion of Snow and Ice (advancing ſtill with its broad Baſis out of the Ocean, in Proportion as the upper Parts melt and diſſolve) muſt be attended with very great and ſenſible Effects upon the *Air* and Vapours of warmer Climates; and often cauſe thoſe unſeaſonable bleak Winds, and Storms of Hail in the Summer Months, which ſome Philoſophers have with Reaſon aſcribed to them.

As the polar Regions are the inexhauſtible Stores and Magazines of Cold, I ſhall only add, what *Dampier* and other Travellers confirm; that in the *Southern* Latitudes beyond the Tropic, the *South* Wind is as remarkable for being cold, and the *North* Wind for bringing Heat and Thunder-Storms, as the contrary are with us. So that on each Side of the Globe, at equal Diſtances from the Line, the very ſame Eſtimate may be reaſonably made, both of the Temper of the Winds, of the State and Weight of the *Atmoſphere*, and of the Quality of the Weather: And the ſame general Rules and Obſervations upon the *Barometer*, will, conſequently *(mutatis mutandis)* hold good in one *Hemiſphere*, as well as in the other.

To make the Changes in the Gravitation of the *Air* more diſcernable, ſeveral Inſtruments have been contrived, and Additions made to the *Barometer*. The firſt, was by affixing to it, a circular Plate of Braſs, divided into equal Parts, and figured, with a Pulley in the Centre, and a Weight ſuſpended, turning a moveable Hand backwards and forwards, according to the Riſe or Fall of the *Mercury*; and thereby diſcovering and pointing out, upon the figured Plate, any the leaſt Change, or Variation in the Weight of the *Air*. But this Inſtrument was found to have this Inconvenience, that, in ſome Meaſure, defeated the Truth and Exactneſs of it, *viz.* The Cord, or String, to which the Weight, moving the Pulley, hung, would in damp Weather be contracted, and in dry Weather be extended; and, by ſuch Contraction, or Extenſion, turn the Hand, though, in the mean Time, the *Mercury* had neither riſen, nor fallen.

To remedy this, another *Barometer* was contrived, with that Part of the Tube, where the Quickſilver riſes and falls, of a larger Baſe; and a ſlender Pipe (immerged in Oil of *Tartar*, ſwimming upon the Quickſilver) riſing from it to the Height of 36, or 40 Inches; and each ſo proportioned, that for every Inch the *Mercury* aſcended in the larger Tube, the Oil of *Tartar*, in the ſlender Pipe, might riſe 10 Inches. But this alſo was attended with much the ſame Inconvenience as the Wheel *Barometer*. For as the Weather grows Hot, or Cold, the Oil will rarefy, or condenſe, and, by Conſequence, riſe or fall, when the *Mercury* is no ways altered in its Situation.

SINCE therefore the *Mercury* will always riſe in Proportion to the Weight of the *Air*, and remain at the ſame perpendicular Height, however the Tube be inclined;

clined: The beſt and moſt convenient Contrivance for a *Barometer*, ſeems to be that of a ſloping Tube, riſing upright from the ſtagnant *Mercury* to the Height of 28 Inches; and then reclining and running off in an Angle, to the Length of 12 Inches, and to the perpendicular Height of 3 Inches; according to which Frame, for every Inch that the *Mercury* riſes in the perpendicular Tube, it will riſe in the ſloping Tube 4 Inches; and thereby make any Changes in the Gravitation of the *Air* more diſcernable.

BESIDES theſe, there are other *Barometers* of a more modern Invention, contrived ſo as to increaſe the Riſe and Fall of the *Mercury* to 30, 60, or even to 100 Inches; but then as they are more nice and accurate in their Conſtruction, and difficult in their Management, they are fitter for the Cloſets, and Speculations of Philoſophers, than to be introduced into common Uſe, or accommodated to the ordinary Capacities of Mankind.

BUT whatever Uſe they are deſigned for, or how different ſoever their Effects and Appearances may be; they are all of them to be accounted for upon the ſame Philoſophical Principles, *viz.* by the Weight, or Spring of the *Air*, or both together, acting in a manner ſuitable to the daily Alterations liable to be produced in them.

At the Cloſe of this Account of the *Barometer*, it may not be improper to add an Abſtract of ſuch Obſervations as have been made upon it, by Perſons of unqueſtionable Skill and Authority. Thoſe of the celebrated Dr. *Halley*, (which are the main Grounds of this Diſcourſe, and to which moſt of the Obſervations ſince made, are in ſome Degree, referable) are as follows.

1. That in calm Weather, when the *Air* is inclined to Rain, the *Mercury* is commonly low.

2. That it is generally high in good, ſerene, ſettled, fair Weather.

3. That it ſinks loweſt of all on very great Winds, though they are not accompanied with Rain, according to the Point of the Compaſs from whence they blow.

4. That, *cæteris paribus*, the greateſt Height of the *Mercury* is found, when an *Eaſterly*, or *North-Eaſterly* Wind blows; if it be not too ſtrong.

5. That in calm froſty Weather, the *Mercury* is generally high.

6. THAT after very great Storms of Wind, when the *Mercury* has been low, it uſually riſes very faſt.

7. THAT in the Latitude of 45° and about Ten Degrees on each ſide (being the Seat of the variable Winds) is the greateſt Variation of the Height of the *Mercury*; the Riſe and Fall of it gradually decreaſing towards the *Æquator*, and *Poles*; ſo as within the Tropics, and near the Polar Circles, to ſtand at near the ſame Height in all Weathers.

FOR the Satisfaction of the Curious, I ſhall here inſert, as I find it ſtated by a learned Author, the general Scale of the *Barometer* in all Latitudes, *viz.* near, or under the Line, the *Mercury* is obſerved to riſe, or fall, about Two or Three Tenths of an Inch. At 15 Degrees Latitude, either *North*, or *South*, one Inch. At 30 Degrees 2 Inches. At 45 Degrees, 3 Inches. At 60 Degrees, the Riſe, or Fall, diminiſhes again to 2 Inches. At 75 Degrees, to 1 Inch. And in 81 Degrees, to leſs than a fourth Part of an Inch. And as for the intermediate Spaces betwixt the Numbers ſpecified, the Riſe or Declenſion of the *Mercury*, is gradual, in Proportion as the Latitude approaches nearer to, or recedes from the 45th Degree; though according to Dr. *Halley*, from 35, to 55 Degrees (upon

Account of the different Temper, Changeableneſs, and frequent Oppoſition of the Winds, within thoſe Latitudes) the *Mercury*, taking its hgheſt Riſe, and loweſt Fall, varies little from the ſtated Height of 3 Inches.

THIS general Eſtimate, we muſt here remark, is ſettled chiefly with regard to the ordinary Courſe of the Weather; for in violent Storms and Hurricanes, which ſometimes happen within the Tropics, the Depreſſion of the *Mercury* is much lower than the Proportion here allotted to it. And to this I ſhall farther add, that the Station and Height of the *Barometer* muſt alſo be taken upon, or near the Sea-Coaſts; becauſe within the Continent, in Proportion to the Height of the Land above the Level of the Sea, the Scale of the *Barometer* diminiſhes in all Latitudes.

THE following Rules whereby to judge of the Weather, are delivered by Dr. *Harris*, as the Reſult of Mr. *Patrick*'s long Obſervation and Experience.

1. IN the *Barometer* of common Form, the Motion of the *Mercury* does not exceed 3 Inches in its Riſing, or Falling.

2. THAT its leaſt Alterations are to be minded, in order to the judging rightly of the Weather by it.

3. THE Riſing of the *Mercury* preſages, in general, fair Weather; and its Falling, foul Weather; as Rain, Snow, high Winds and Storms.

4. IN very hot Weather, the Falling of the *Mercury* foreſhews Thunder.

5. IN Winter, the Riſing preſages Froſt; and in froſty Weather, if the *Mercury* falls three or four Diviſions, there will certainly follow a Thaw. But in a continued Froſt, if the *Mercury* riſes, it will certainly ſnow.

6. WHEN foul Weather happens ſoon after the Falling of the *Mercury*, expect but little of it. And, on the contrary, expect but little fair Weather, when it proves fair, ſhortly after the *Mercury* has riſen.

7. IN foul Weather, when the *Mercury* riſes much and high, and ſo continues for two or three Days before the foul Weather is quite over, then expect a Continuance of fair Weather to follow.

8. IN fair Weather, when the *Mercury* falls much and low, and thus continues for two or three Days before the Rain comes; then expect a great deal of Wet, and probably high Winds.

9. The unſettled Motion of the *Mercury* denotes uncertain and changeable Weather.

10. You are not ſo ſtrictly to obſerve the Words engraven on the Plates (though for the moſt Part it will agree with them) as the *Mercury*'s Riſing and Falling: For if it ſtands at much Rain, and then riſes up to Changeable, it preſages fair Weather; although not to continue ſo long, as it would have done, if the *Mercury* were higher: And ſo on the contrary, if the *Mercury* ſtood at Fair, and falls to Changeable, it preſages foul Weather; though not ſo much of it, as if it had ſunk down lower. *Vide Harris*'s *Lexicon*, under *Barometer*, where Dr. *Halley*'s Obſervations, with the Reaſons of them, are alſo inſerted.

It would be often of great Conſequence to form a probable Judgment ſome few Hours before hand, of the enſuing State of the Weather; whether it may be likely to continue, or liable to a ſudden Alteration: But although in ſuch an Enquiry (by the peculiar Situation and Uncertainty of our Climate) we can arrive at little more than bare Conjectures; yet even here, a good *Barometer* will be of Service to us, in giving us ſome little Light and Intimation. But then, in this Caſe, we muſt confine our Inſpection wholly to the Surface of the *Mercury*

cury within the Tube; and examine the particular Figure and Appearance of it, with great Strictneſs and Attention.

1. If in a common upright *Barometer*, the Surface of the *Mercury* appears perfectly plain and level, the Preſſure of the *Air* is equal and ſteady; and the Weather will generally continue for ſome Hours, much the ſame, as about the Time of Obſervation.

2. If in wet Weather, it appears round, or convex, riſing higher in the middle of the Tube, than at the Sides, the Preſſure of the *Air* is encreaſing, and an Interval of fair Weather will commonly follow ſoon after.

3. If in changeable, or fair Weather, the Surface of the *Mercury* appears to be concave, or depreſſed more in the middle, than at the Sides of the Tube; the Preſſure of the *Air* is decreaſing, and the Weather will, in a few Hours, become cloudy, and ſometimes rainy or windy. (Theſe Obſervations, it muſt be added, require a clear Tube of near half an Inch in Diameter, the pureſt Quickſilver, and a ſtrong Side-light, to make them diſtinct and viſible; but if the Tube be ſmall, the Light weak, and at a Diſtance, or the *Mercury* foul and droſſy, the different Appearances of the Surface,

will be ſcarce diſtinguiſhable, or aſcertained to any Truth, or Exactneſs).

4. In all Judgments formed of the enſuing Weather, it is a main *Poſtulatum*, that the Wind continues in the ſame State and Quarter; for if there be a ſudden Change, Encreaſe, or Oppoſition of Winds, the Weather, for the Reaſons above given, will commonly change, and take a different Turn with them.

After ſo large and full an Account of the Nature, Reaſons and Uſes of the common Sort of *Barometers*, it may perhaps be in ſome meaſure ſerviceable, or entertaining to ſeveral of my Readers, to add two or three eaſy Rules for trying and judging of the Goodneſs and Sufficiency of them, as well as for amending ſuch Defects as are ordinarily found in ſome of them. As,

In a *Barometer* adjuſted to a Situation and Scale of three Inches, obſerve the Diſtance from the Surface of the ſtagnant *Mercury*, to the loweſt Line upon the graduated Plate (when that within the Tube ſtands at changeable) that it be exactly 28 Inches; if it be more, the Quickſilver can never riſe to ſettled Fair; if it be leſs, it can never ſink to Stormy. In the former Caſe, ſhorten the Tube, by grinding, or filing, and then either add to the *Mercury*, or raiſe the Ciſtern higher: In the latter Caſe, ſink the Vertex of the Tube, and the Ciſtern lower.

2. LAY your Finger, with a gentle Depreſſion, upon the ſtagnant *Mercury*; and if it immediately riſes and vibrates in the Tube above; it is to a juſt Degree ſenſible of the Changes in the Gravitation of the *Air*; but if it produces no correſpondent Motion in the *Mercury* within the Tube, it is a certain Indication, that the Cavity of the Tube is too narrow, and not allowing ſufficient room for the free Play of the Quickſilver, you muſt change the Tube for one of a wider Bore, and place it in its Stead.

A ſmall Tube will, it is evident, ſave Quickſilver, but be of little Uſe in judging of the Weather; becauſe by the Coheſion of the Parts of the *Mercury* in ſo ſlender a Cylinder, by the Reſiſtance and Oppoſition of the Sides of the Tube; or, perhaps, by ſome little Aſperities within the Motion produced in it will be ſo very ſlow and dilatory, that I have often obſerved the *Mercury* not to begin to fall, 'till the Day after a Glut of Rain; nor to riſe to its proper Height, 'till two or three Days after the Setting in of fair Weather. So, that in this Reſpect, a ſlender Tube, not unlike the *Ladies Almanack*, gives no notice of the

Changes of the Weather, 'till they are actually paſt.

3. The common Sort of Quickſilver, after it has ſtood in a *Barometer* ſeveral Years, becomes leſs ſenſible of the Impreſſions of the *Air*, leſs capable of anſwering, by a correſpondent Motion, the different Changes in its Gravitation.

This may be cauſed, either by the droſſy Parts of the Quickſilver, riſing to the Top, and adhering to the Sides of the Tube; or by ſome imperceptible Bubbles of *Air* diſengaging and expanding themſelves in the Vertex of the Tube; which, we have obſerved above, ought to be void of *Air*.

For, if (according to Mr. *Boyle's* Calcuculation, when the Preſſures of the *Atmoſphere* is taken off) a cubical Inch of common *Air*, will extend itſelf above 10,000 times its natural Dimenſions; it is certain that two or three Bubbles of *Air*, expanded in ſuch a Proportion, will be more than ſufficient to fill up the Vertex of the Tube; and thereby obſtruct the Riſing or Force of the Deſcent of the *Mercury*, below its proper Standard.

In this latter Caſe, apply a live Coal, or hot Iron, to the upper Extremity of the Tube; and the Rarefaction of the *Air* (if there be any) when encreaſed by the Heat, will immediately diſcover itſelf in the Depreſſion of the *Mercury*.

But the Remedy in both Caſes is the ſame, *viz.* to take out the Tube and the Quickſilver, and after cleaning the Tube well within, and clearing off the droſſy Parts of the Quickſilver with great Care and Exactneſs, fill the Tube, with a competent Addition of freſh *Mercury*, and fix it up again.

4. If the Tube be thin, and the Bore wide, you muſt tie it to a pliable Stick, or Whalebone, of equal length, before you fill, or invert the Tube: Otherwiſe, the Weight of the Quickſilver will endanger the Breaking of the Tube.

It is alſo of ſome Conſequence, when the Tube is large, and the Bore wide, to have the Ciſtern large in Proportion, and entring ſo far into the back Part of the Frame, as to admit of the Suſpenſion of the Tube, in, or near the Centre, and thereby allowing a circular Column of *Air* free Play in acting upon the ſtagnant *Mercury*: By which means, as the Weight, or Preſſure of the *Air*, will be more equal, ſteady and uniform; ſo the Riſe and Fall of the *Mercury* will be more entire, regular and ſenſible.

In ſhort, the finer and purer the Quickſilver is, the larger the Tube, and the more exactly ſmooth and cylindrical the

Cavity within; with ſo much the greater Freedom and Facility will the *Mercury* play, and, conſequently, more plainly and ſenſibly ſhew any notable Change in the Gravitation of the *Air*.

By a moderate Attention to what has been delivered upon this Subject, even People of ordinary Capacities, may rightly apprehend, and competently underſtand, the Nature and Uſe of the *Weather-Glaſs*; and find it of real Service to them, in the proper Direction and Accommodation of their rural Affairs: There being no remarkable Change, or laſting Interval of any Sort of Weather, but what the *Barometer*, to a careful and ſkilful Obſerver, gives ſure and previous Notice, both of the Setting in, the Continuance, and Determination of it, ſo as not to leave ſuch as attend to it, altogether under the ſame Uncertainty with thoſe who judge at random, without any natural Grounds, or Preſages, to ſupport their Conjectures.

But then, in order to form from thence a probable Judgment of the State of the Weather, the *Barometers* we conſult muſt be good in their Kind, and nicely ſenſible of the Impreſſions of the *Atmoſphere*: And all ſuch Perſons as would be curious in them, and well aſſured of the Truth and Exactneſs of thoſe Inſtruments, upon which they ground their Obſervations, muſt not grudge the Expence of purchaſing from the very beſt Hands.

As for ſuch *Weather-Glaſſes*, as have been lately hawked about the Country, by needy Foreigners, or pedling Philoſophers; it may not be improper to caution my Readers, that they are, generally ſpeaking, very great Cheats and Impoſitions upon thoſe, who, for the Sake of the Meanneſs of the Price, are perſuaded to buy them; the cavity of the Tube, being, in many of them, ſcarce large enough to receive an ordinary Pin; and the Quantity of Quickſilver being, conſequently, too ſmall, either to force the *Air* out of the Tube, at the firſt, or to be regularly affected by it afterwards, according to the Difference of its Gravitation.

FINIS.

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